

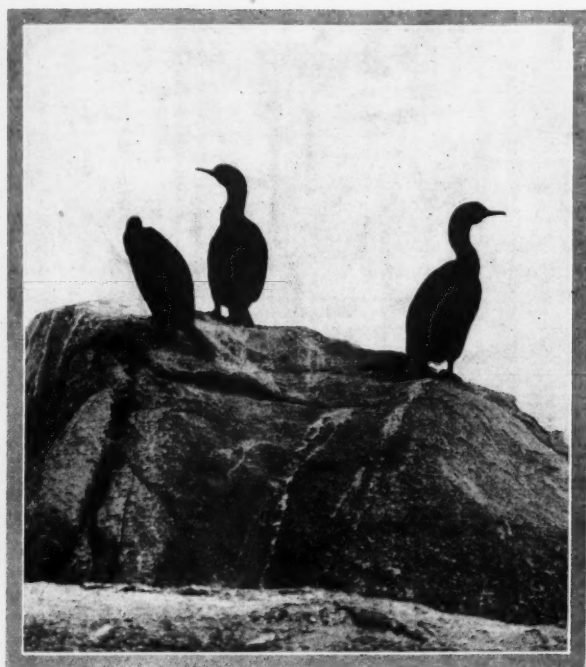
DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII, No. 75. MARCH, 1926

(Annual Subscription 12s.6d. Post Free).

PRICE 1s. NET



DEEP-SEA ANGLERS

CONTENTS

	PAGES.
Editorial Notes ...	77
A Milton Mystery ...	79
Bird Migration in Egypt ...	83
Ostia, Rome's Ancient Port ...	88
Tweed, Sheep and Tartans ...	93
Bladderworts (Utricularia) ...	97
Sub-tropical Meteorology in the Transvaal... ..	100
The Sense of Smell ...	105
Soil Bacteria and Nitrogen Fixation ...	109
Book Reviews ...	113

Remington PORTABLE

£2 : 2 : 0

with order

The balance may be paid by 11 monthly instalments of £1

CASH PRICE
£12 : 10 : 0

The SOUNDEST and the MOST COMPACT Portable Typewriter made

It has the Standard keyboard, one shift only for capitals, automatic ribbon reverse, and is covered by our world-service guarantee. It is so handy it can be carried and used anywhere. It has the sturdiness of all Remington machines.

WRITE FOR FULL PARTICULARS, "D"

THE REMINGTON TYPEWRITER CO. LTD.
Head Office : 100 Gracechurch Street, London, E.C.3
And at 4 St. Paul's Churchyard, London, E.C.4. Branches in principal Provincial Centres



Complete in case it weighs only 11 lb. and stands 4 in. high.

THE MODERN WORLD

A Survey of Historical Forces

EDITED BY

THE RT. HON. H. A. L. FISHER, M.P.

"The series as a whole will be indispensable to any serious student of international affairs."—*New Statesman*.

ALREADY PUBLISHED

INDIA. By Sir Valentine Chirol. ... 15s.

"Shows the complexities and perplexities of India in their true historical perspective... invaluable."—*Morning Post*.

"Excellent reading, packed with relevant record and illuminative comment... may help to dispel the crudities about Indian affairs habitually fed to the public."—*LORD OLIVIER* in *The Nation*.

RUSSIA. By N. Makeev and V. J. O'Hara. ... 15s.

"Incomparably the best book which has appeared in English since the Bolshevik Revolution."—*New Statesman*.

GERMANY. By G. P. Gooch. (*Second impression*) ... 15s.

"The first authoritative, impartial and comprehensive survey of Germany since the war."—*Daily News*.

NORWAY. By G. Gathorne Hardy ... 15s.

"Liberal, well-reasoned and humane, fully of learning gaily borne... its every chapter leaves the reader more indebted."—*Times*.

IRELAND. By Stephen Gwynn. ... 12s. 6d.

"We know of no more searching study of Irish life."—*Manchester Guardian*.

READY SHORTLY

TURKEY. By Arnold Toynbee. **ENGLAND.** By the Very Rev. W. R. Inge.

IRAQ. By Gertrude Bell.

A PROSPECTUS OF THE SERIES WILL BE SENT ON APPLICATION

ERNEST BENN, LTD., 8, BOUVERIE STREET, LONDON, E.C.4

ASTOUNDING MICROSCOPE OFFER



We have for disposal **35 ONLY**, RESEARCH and BACTERIOLOGICAL microscopes, by the well-known maker, KORISTKA, as illustrated—surplus stock.

These microscopes are guaranteed to be optically perfect and quite new. The usual list price is £32 10 0. We are disposing of these instruments at the ridiculously low figure of £19 19 0 each to clear.

Prompt application must be made to avoid disappointment, as the whole of these microscopes are sure to be sold within a few days of the appearance of this announcement.

The offer consists of a KORISTKA MICROSCOPE, as illustrated, fitted with double rack and pinion coarse and fine screw focusing adjustment, Abbé condenser, with Iris diaphragm, with screw underfilling, revolving stage, triple revolving nose-piece, objectives, $\frac{3}{8}$, $\frac{1}{4}$, $1\frac{1}{2}$ ", oil immersion, and 3 eye-pieces, complete in velvet-lined carrying case.

Seven days' approval against deposit. Send remittance at once to secure.

Instalments accepted—59/- cash and 12 payments of £1 11s. 3d.

THE MOST MARVELLOUS VALUE EVER OFFERED IN A HIGH-GRADE MICROSCOPE BY A MAKER OF REPUTE. GUARANTEED OPTICALLY PERFECT.

CITY SALE & EXCHANGE, LTD., 81 ALDERSGATE, LONDON, E.C.1



DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII, No. 75. MARCH, 1926.

• PRICE 1s. NET

Trustees: SIR J. J. THOMSON, O.M., F.R.S., SIR F. G. KENYON, K.C.B., F.B.A., PROF. A. C. SEWARD, Sc.D., F.R.S., PROF. R. S. CONWAY, Litt.D., F.B.A.

Edited by HUGH B. C. POLLARD.

Publishers: BENN BROTHERS, LTD. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager.

Offices: 8 Bouverie Street, London, E.C.4.

Telephone: City 9852 (6 lines).

Telegrams: Benbrolish, Fleet.

Annual Subscription, 12s. 6d. post free anywhere in the world. Single numbers, 1s. net; postage, 2d.

Binding cases for Vol. VI, 1925, are now ready. Price 2s. 6d. net each; postage, 6d.

Editorial Notes.

IN the old days people could comfortably divide things up under the heading of "The World, the Flesh, and the Devil." Now we have got science embracing all aspects—Isostasy, Cytology, and the Devil. The latter was exhibited the other day, perhaps only as a Beta ray or an emanation, but, anyway, they had a "Witch in a bottle" at the soiree of the Royal Anthropological Society. It was a nice bottle of silvered lustre ware, cramped in the middle like a pilgrim's gourd, and contained a witch, exorcised, distilled or sublimated (I am a bit shaky on technique in matters infernal), that had been in the bottle and in possession of a Sussex family for over a hundred years. There were many far more important exhibits than this at the soiree, but it has a special interest of its own. It is what an auctioneer would call a "speculative lot." Serious-minded people may champ on their dentition and glare through their horn-rimmed glasses declaring that it is (a) impossible to put a witch into a bottle; (b) that there are no witches; (c) that I am a trifler with the truth. Of these (c) is the only charge capable of disproof. I am, of course, inaccurate and unscrupulous, but there really was a witch in a bottle officially certified as such. You can write to the secretary about it and ask him. I asked him if there really was a witch in the bottle and he gave me a scientific reply. I suggested that it would be a graceful and Christian action to let the lady out, but after a little discussion we both felt that even if we

prevailed on the owner to open the bottle the witch might not care to come out. After all, having enjoyed a century of uninterrupted quietude it would be rather an abrupt change for a vintage witch bottled in the days when Boney's frigates hung off the coast and free trading was in vogue to bob out in twentieth-century Bloomsbury. Besides, they are a hardbitten lot, these anthropologists. They drank their coffee and ate cakes in a little room lined with pigeon-holes. Each pigeon-hole held a skull, very hungry-looking skulls some of them, but the anthropologists don't mind them a bit. They are misleading people. A benevolent-looking lady was pointed out to me as having lived for some years among head-hunters. A glance at the head rack showed me that she had contributed a skull or so to the collection and kept her own properly joined to its spinal column. She would tell you all the anatomical arithmetic of these crania, snappy facts about the Frankfort line and the frontal sinus, but there was not a whisper of the really interesting story—how she got them. That was perhaps the keynote of the gathering of people there. Everyone had been somewhere and done something; there was authority and knowledge, not simply booklore and the dust of learning assiduously acquired in England, but a human atmosphere. It was exactly as if you had collected all the interesting people out of the smoking rooms of a dozen ocean-going liners sailing the seven seas. I have a feeling that I know dozens of people overseas and returned from overseas who would find the Royal Anthropological Society exactly the kind of thing they want. It is astonishingly interesting and, as I say (and I hope the Society will forgive me), it may be learned but it is not dull. Now the average man is shy of approaching any learned society unless some member takes him by the hand and leads him in. This is natural, for the unknown is usually terrifying, but in this case there is no need for shyness. The Society has a floating population straggling unconcernedly about the world, and you will probably find someone who knows your own bit of country or some neighbourly bit of the subcontinent

or territory. If you have any interest in native customs, weapons, habits, history, or even, not knowing much about these things yourself, would like to know what others know about them, or if you live rather out of touch with the world and would like to get into touch with folk who are genuinely interested in matters which may be a commonplace of your life out there, then write to the Secretary, the Royal Anthropological Society, 52 Upper Bedford Place, and say that you gather from *Discovery* that it is rather a good thing and will he send particulars.

* * * * *

There is little to be said at the moment about impending discoveries. Rumours come from Egypt about tombs which outrank Tutankhamen's in splendour, but the people who presumably know about these things caution reserve and seem sceptical. There is an Arabian or American saying: "The air of the desert is very hot, but the hot air brings in subscriptions." This wind seems to cross the Mediterranean, for latterly a few paragraphs have appeared in the papers about some Italian professor who has solved the riddle of the unknown Etruscan language. According to reports he finds that it is Archaic Greek written backwards and in a form of shorthand. The press notices include a preliminary announcement of his forthcoming book, and the whole affair seems to be one of the now familiar publicity attempts of the ingenious Italians. Aldous Huxley had something to say about the Etruscan language in "Barren Leaves." I have not the book by me so cannot quote, but one of his characters reflecting upon Etruscan inscriptions was, if I remember correctly, moved to consider it the ultimate goal of a classical education. It was a language whose relics amounted to a few hundred words, nobody understood it, and it was utterly useless and futile—"What learning could be more fitting for an English gentleman if only it could be deciphered?" There is, I fear, a levity in Mr. Aldous Huxley's works that classical scholars of to-day will disapprove. Attacks on the classics are easily refuted, but a careless jibe such as might deter some wealthy cotton spinner from endowing a chair of Etruscan language is to be deplored. The modernist may attack the classicist, but the world in general recognizes the indefinable character-building effect of classical scholarship. It is something which we associate with tolerance, honesty of purpose, a serene indifference to the fluctuations of our troubled time, a personal charm bred of a real understanding of philosophy and, above all, an unflinching honesty beyond intrigue and incapable of pettiness. It is a high standard, a rule of life, yet it is the distinguishing

factor between the scholar and the place-seeking academic. The classicists fighting a rearguard action against the inevitable must justify their claims in the personality of their leaders. In other parts of the world the lamps of classical learning burn low, but we in Britain are singularly fortunate in having individuals who inspire and hearten the rank and file who do so much to form the body of public opinion. The older universities compete for such men when a post falls vacant. Those whose academic qualifications may be great, but whose personality is indifferent, remain in exile. Failure carries no stigma, but the academic world knows, sometimes it sympathizes, always it understands. To succeed a man must be square and sound.

* * * * *

This is the last number of *Discovery* under my editorship. Two years ago it was a moribund infant, and I took it over at short notice. I want to thank my patient readers for the way they have put up with our various teething troubles, setbacks, lapses from propriety, misprints, and all sorts of things which should never happen if a paper was a purely mechanical production. As it is, there is still a human element in the making of a paper, and when I look back over the two years' bound volumes I blush for my errors and yet feel fairly proud of the thing as a whole. It is a fairly healthy infant now, and is old enough to have a nursery governess. Mr. John Benn, son of the publisher, succeeds me in the chair, and I can imagine no more fortunate omen for *Discovery*. The paper is not quite the ordinary sort of paper. There has always been some indefinite kind of team spirit about the thing. Contributors, readers, and editor have enjoyed a common interest in the paper, and I feel that I am saying goodbye to a number of charming and friendly people whom I know but have never seen. People on whaling ships in the Antarctic, men up-country in Chinese mission stations, pearlmen in the South Seas, zoologists on coral islands, men in Vancouver, in Colombia, Shan States, or wherever you be, odd correspondents whom I have welcomed from all the ends of the world, it has been a good little paper. Sons of the Empire, sons of the widow, do me justice. Farewell.

A CORRECTION.

IN our issue of January, in Sister Monica Taylor's article on Micro-Aquaria, there was a reference to some P.H. indicator "tabloids." This word should be tablet, as the word "tabloid" is confined to the products of Messrs. Burroughs & Wellcome. The right tablets to use are those of Messrs. Allen & Hanbury.

New Light on a Milton Mystery.

By C. Ainsworth Mitchell, M.A., F.I.C.

For more than fifty years the authorship of a manuscript poem has been disputed. Some scholars hold that it was the work of young Milton, others that it was not from his pen. The author of this article, whose work on the Mary Queen of Scots letters will be remembered, now gives us a new clue: "Some mute inglorious Milton here may rest—."

AMONG the treasures of the King's Library in the British Museum is a little volume of the first edition of Milton's earlier poems, published in 1645, which some fifty-eight years ago was the cause of a remarkable literary controversy now almost forgotten. In 1868 Henry Morley (Professor of Literature in University College, London), discovered some verses written on the final blank leaf of this book, and on 16th July of that year wrote a letter to *The Times* to the effect that he had discovered an unpublished poem by Milton.

A Find.

"The handwriting on this blank page," he says, "to anyone familiar with the collection of facsimiles in the late Mr. Sotheby's 'Ramblings in the Elucidation of the Autograph of Milton' would, I think, convey at first glance the impression it conveyed to me, that this was the handwriting of John Milton. It proved to be a transcript of a poem in fifty-four lines which Milton, either for himself or for some friend, had added to this volume. It is entitled 'An Epitaph,' and signed by him 'J. M. O'ber, 1647.' He was then in his thirty-ninth year."



FIG. 1.
REPRODUCTION OF THE LAST PAGE OF "MILTON'S POEMS," 1645.
[By kind permission of the British Museum.]

Morley's claim did not long remain unchallenged, for Masson, an even greater authority, wrote to *The Times* (21st July, 1868), that he was already familiar with this poem, and had formed the opinion that the internal evidence was against its being by Milton, but that in his view the question of the handwriting would be conclusive. Referring to the doubtful signature he says, "Though I copied it as 'J. M.', as Mr. Morley has also done, I find a query attached to my copy whether I was right in making the first letter 'J.'"

Similarities.

With these two authorities as protagonists the students of Milton were divided into two camps. On the one side were those who contended that the similarities of style (apart from resemblances in the writing and the signature "J. M.") were too good for an imitator, and who

asked, If Milton did not write the poem who could have written it? On the other side were those who, while admitting some similarities in the writing (which, however, they did not consider conclusive, especially in view of the doubtful initial)

and conceding the fact that the metre and much of the imagery and phrasing were characteristic of Milton, yet urged that it was not beyond the power of a skilled imitator with a good ear for rhythm, and that certain features in the poem afforded evidence against its being by Milton.

Morley's Belief.

The controversy in *The Times* continued for several months, each point for and against the authenticity of the lines being fully discussed, often with considerable acrimony, and when at length it died away it left the question at issue still unsettled. Morley's last word on the subject was in the introduction to a volume of Cavalier and Puritan song, "The King and Commons" (1868), where he reiterated his belief that the handwriting was that of Milton, the initials "J. M.", and that even if it were proved that someone else had transcribed the poem, the author was John Milton.

In the following transcription the exact form of spelling and use of capitals in the original are shown, and illegible or doubtful parts of words are put in brackets.

AN EPITAPH.

He whom Heaven did call away
Out of this Hermitage of clay
Has left some reliques in this Urne
As a pledge of his returne.
Meanwhile ye muses doe deplore
The loss of this their paramour
With whom he sported ere ye day
Budded forth its tender ray.
And now Apollo leaves his laies
And puts on cypres for his bayes.
The sacred sisters tune their quills
Onely too ye blubbering rills
And whilst his doome they think upon
Make their owne teares their Helicon,
Leaving ye two-topt mount divine
To turne votaries to his shrine.

Think not [reader] mee lesse blest
Sleeping in this narrow cist
Than if my ashes did lie hid
Under some stately pyramid.
If a rich tombe makes happy y^e
That Bee was happier far y^e men
Who busie in ye thymie wood
Was fettered by ye golden flood
Wch frō ye Amber-weeping Tree
Distilleth downe so plenteously.
Ffor so this little wanton Elfe
Most gloriously enshrined itselfe.
A tombe whose beauty might compare
With Cleopatra's sepulcher.

In this little bed my dust
In curtain'd round I here entrust,
Whilst my more pure and nobler part
Lyes entomb'd in every heart.

Then pass on gently ye y^e mourne
Touch not this mine hallowed Urne.
These Ashes wch doe here remaine
A vitall tincture still retaine.
A seminall form within ye deeps
Of this little chaos sleeps
The thred of life untwisted is
Into its first Consistencies
Infant Nature cradled here
In its principles appeare.
This plant th[us] calcin'd into dust
In its Ashes rest it must
Until sweet Psyche shall Inspire
A softning and p[ro]lifick fire
And in her fost'ring arms enfold
This Heavy and this Earthly mould;
Then, as I am Ile be no more
But bloome and blossome . . . f . . .
When this cold numnes shall retreat
By a more yn chymick heat.

P. M. 10ber, 1647.

The first two-thirds of these lines are written vertically on the left-hand side of the page, and the remainder horizontally in three columns on the right-hand side (see Fig. 1). Unfortunately the British Museum stamp in yellow ink was placed exactly where it would partly obliterate the first initial of the signature, so that even on close scrutiny this letter can be mistaken (as Morley and many others did mistake it) for "J."

Anyone familiar with Milton's early poems cannot fail to be struck by the similarity in phrasing and imagery between some of them and this poem. For example, the "amber-weeping tree" of "An Epitaph" is reminiscent of "thy amber-dropping hair" in "Comus" (line 863), and "the little wanton Elfe" of the "shrewd meddling Elfe" also in "Comus" (line 846).

Internal Evidence.

Again, in Milton's "Epitaph on the Marchioness of Winchester" there are numerous parallels, such as —

"And in his garland as he stood
Ye might discern a cypress bud." (Lines 21-22)

"Here be tears of perfect moan
Wept for thee in Helicon;
And some flowers and some bays
For thy herse to strew the ways." (Line 55-58).

In "Lycidas" (line 15) there is —

"The Sisters of the sacred well;"

Also (line 185) —

" . . . the uncouth swain to the oaks and rills

He touch'd the tender stops of various quills."

In Milton's "Epitaph on Shakespeare" we have —

"Or that his hallowed reliques should lie hid
Under a star-y-pointed pyramid."

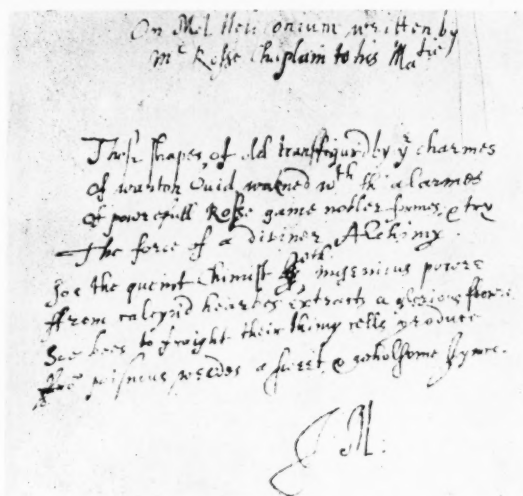


FIG. 2.
POEM IN MILTON'S EARLIER HANDWRITING.

The writer of the disputed poem was also probably acquainted with the verses "On Mel Heliconium," written by Milton about 1642 as an inscription in a book (see Fig. 2), since there is here too the metaphor of bees amid the thyme, and that of a chemical transmutation by "calcyning."

Literary Objections.

It is also suggestive that Milton should have used the expression "distilleth down" in one of the manuscript stanzas recently discovered by Mr. H. Candy in an illustrated copy of Ovid's "Metamorphoses."

Numerous other instances might be cited to show that whoever wrote "An Epitaph" must have been thoroughly familiar with Milton's conceptions and modes of expression and able to use them with effect. He has also succeeded in catching Milton's characteristic subtle rhythm of alternating lines of seven and eight syllables. In the long-drawn-out controversy this poem was wildly attributed to other contemporary writers whose names begin with M, such as Henry More, Jasper Mayne, and Andrew Marvell, but the supporters of the Milton hypothesis urged that none of these writers would have been capable of reproducing this distinctive feature of the rhythm. Among the literary arguments brought against the authorship of Milton was the bad grammar in the couplet—

" Infant Nature cradled here
In its principles appeare."

but this argument loses some of its force now that it

has been shown that Milton has made analogous grammatical slips in other poems in manuscript (cf. Candy, "Some New Stanzas by Milton," p. 81).

A literary objection which carries more weight is the frequent use of the word "its" in the disputed poem. Milton, like other writers of good English of the period, seldom used that pronoun; it occurs only twice in all his better-known poems, and twice in the newly discovered stanzas, and yet it is found no fewer than four times in this little poem of fifty-four lines, and is also used there with reference to personifications, such as Nature, for which Milton commonly used "his" or "her."

Handwriting Variations.

It will be seen, therefore, that if the question had to be decided solely on literary grounds the arguments for and against the authorship of Milton would be fairly evenly balanced, but, as Masson pointed out, the handwriting and the signature are the decisive factors.

In comparing writing of about this date (1647) with accepted writing of Milton it is necessary to take into consideration the fact that his script shows an evolution from the Elizabethan style, as is seen in the verse "On Mel Heliconium" (Fig. 2), into the simpler form that became common in the seventeenth century. A good example of Milton's later style is to be seen in an affidavit of his of 1650 (see Fig. 3).

One characteristic of Milton's earlier writing is the readiness with which he used different forms of letters.

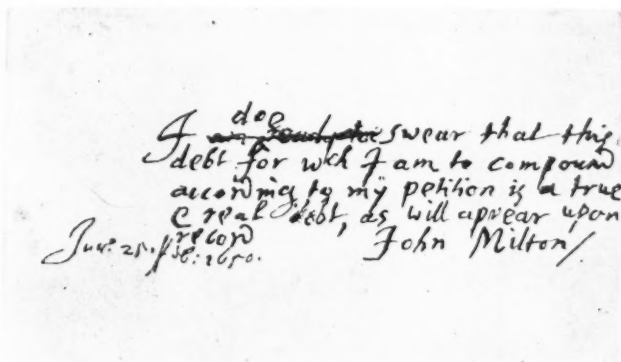


FIG. 3.
AN AFFIDAVIT IN MILTON'S LATER WRITING.

For instance, in the word "weedes" (Fig. 4), there are three different kinds of "e." Variations in the forms of letters are also to be found in "An Epitaph," but they are not the same as those used by Milton. For instance, the old form of "h" (Fig. 4) used

repeatedly in the disputed poem, does not seem to have been used by Milton.

The Greek "e's" common to both writers are of similar character, and although differences can be seen in the particular specimens shown in the figure, it is questionable how far they are decisive. In the case of the "w's" however, there is a characteristic difference. Milton usually made this letter with its first upright lower than its third, whereas in "An Epitaph" the third stroke is usually decidedly higher, so that a line connecting the tops of the two uprights generally runs upwards. Some of the "h's" in the two writings are similar in form, but there is usually a pronounced

wife, his daughters, and his two nephews, Edward and John Phillips: it has not the characteristics of any of their writings; nor does it agree with the writing of Marvell, who in 1868 was suggested as the possible author.

Who is "P. M."?

The negative results of these attempts to fix the authorship of the poem led me back once more to the initials. It will be seen on reference to the specimens of Milton's initialled signatures (Figs. 2 and 3), that the "M" does not correspond with his usual initial, nor does it agree in formation with the small "m's" in his writing. Direct observation of

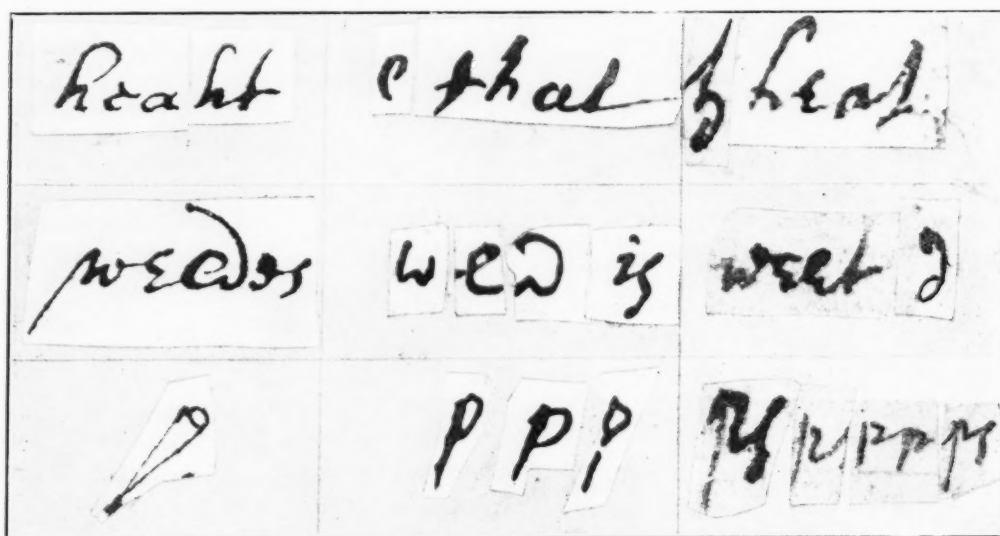


FIG. 4.
ENLARGED PHOTOGRAPHS OF THE WRITING OF MILTON AND THE HANDWRITING IN THE DISPUTED "EPITAPH."
Left-hand column.—Milton's earlier style of writing. Centre.—Milton's later style of writing. Right.—The disputed script.

difference in the relative dimensions of different parts of the letter.

Differences in form and in ratio measurements between the writing of the disputed verses and Milton's handwriting can be found in every word, and these differences far outweigh any occasional resemblances. In short, a minute examination of the characters does not support Morley's claim that the handwriting of "An Epitaph" is that of Milton.

Original Error.

So long, however, as it was not certain that the initials were not "J. M.", the fact that the poem was not in Milton's writing did not exclude the possibility of its being a poem by him written down by someone else. I therefore compared the writing with that of all his known or probable amanuenses, including his

the first initial under a low magnification indicated that it was probably not "J," but might be "P" or "R." This deduction was carried a stage further by means of the greater differentiation effected by photography with a coloured screen and colour-sensitive plate, and in the prints from the negative it could be distinctly made out that the letter was not "J" but was probably "P." Lastly, by making an enlargement from the negative (for which I am indebted to Mr. T. J. Ward), and blocking out with zinc white the marks of the British Museum stamp, the outline of the letter "P" was demonstrated with certainty (see Fig. 5). This letter "P" is similar in formation to the small "p's" and to the capital "P" in "Psyche" in the poem (see Fig. 4).

This definite proof that the final initials are not "J. M." but "P. M.," and that they are in the same

writing as the text, disposes of the hypothesis that the poem was dictated by Milton and then initialled by him. I have been unable to discover any contemporary writer with initials "P. M." whose writing agrees with that of "An Epitaph." It is not in the handwriting of Phillip Meadows, who was appointed to assist Milton as Latin Secretary to the Council of State.

The most plausible hypothesis is that some unknown friend or admirer ("P. M.") of Milton, who had considerable poetic skill and a good ear for rhythm, acquired this little volume and wrote in it a prospective epitaph on Milton himself in which he succeeded in catching not only the poet's style and metre, but also the spirit of his poetry.

I may add that Mr. Candy, who is probably more familiar with the writings of Milton than anyone now

living, agrees with my conclusions, and has suggested to me that it is even feasible that this poem may also have a metaphorical significance and that it was the writer's intention to mourn the loss to literature when Milton became absorbed by politics, and to point to this little volume of poems as "the pledge of his return" to poetry—a pledge which was in fact redeemed in after years.



FIG. 5—ENLARGEMENT OF INITIALS IN THE SIGNATURE TO "AN EPITAPH."

BIBLIOGRAPHY.

- CANDY, H. C. H.—"Some Newly Discovered Stanzas of John Milton." (Nesbit & Co. London, 1924).
 MASSON, D.—*The Times*, 21st July, 1868.
 MILTON.—"Poems of Mr. John Milton." London, 1645. (British Museum Press Mark 238. h. 35).
 MORLEY, H.—*The Times*, 16th and 20th July, 1868. "The King and Commons" (Cavalier and Puritan Song). London, 1868.
 SOTHEBY, S. L.—"Ramblings in the Elucidation of the Autograph of Milton." London, 1861.

Bird Migration in Egypt.

By R. E. Moreau.

In March the luxurious birds who have wintered in the warmth of Egypt move north again to their breeding grounds. They have to face a four-hundred-mile sea-crossing and a desert trip three times as long. Very little is known about the conditions governing the line of migration, and further observations are required.

AFTER the opening of the Suez Canal the Khedive Ismail is reported to have said: "My country is not a part of Africa but of Europe." However true this may be politically, it is far more so ornithologically, for the list of Egyptian birds is composed almost entirely of Palaearctic forms. That is to say, most of the birds encountered here are recognizable relatives of those with which we are familiar in Europe. So far something like four hundred and fifty species and subspecies have been recorded in the country. Barely one hundred have been known to breed here, and even this small number includes many local races and very sparsely distributed inhabitants of the deserts. A much greater variety of species and many more individuals are to be seen in winter than in summer, but these again are vastly exceeded by the multitudinous passage migrants which breed north of the Mediterranean.

English Visitors.

So it comes about that at their proper seasons many of the favourite British birds, like the robin, thrush, stonechat, and curlew, occur in Egypt. As a matter of fact, these species are often represented by European

geographical races and probably always by individuals breeding in Central or Eastern Europe; the evidence derived from ringed birds points to a probability that the birds which nest in summer in Britain travel backwards and forwards from Africa in touch with the Atlantic seaboard. In addition we see here in Egypt some of the strange and splendid European breeding birds which occur in Britain rarely or not at all—the black stork and the white, the grey and demoiselle cranes, the rock thrushes, the roller, the bee-eater, the pratincole, the blue-throats, and many more.

European Migrants.

It is difficult to do justice in any words to the magnificence of the Egyptian phenomena. They are remarkable, not only from their overwhelming impressiveness, but also for the unsolved problems they present to investigators yet to come. The thronging richness of the migration of both spring and autumn is ultimately due to the geographical situation of Egypt, which, together with its topography, we must consider for a moment. Egypt lies wholly



within the great desert zone, twelve hundred miles from north to south, which extends from the Mediterranean Sea to the northern edge of the Equatorial rain-belt, a little south of Khartum. In the accompanying sketch map the undotted areas represent desert. The narrow strip of vegetation shown along the Mediterranean coast exists only in spring, and at the time of the birds' southward passage at the end of summer the desert comes without a break to the edge of the waves. To the east, across Arabia, and to the west as far as the Atlantic, the same arid conditions continue unbroken. On the north of Egypt, across the Mediterranean, the land-masses of Europe and Western Asia support an immense population of birds which breed there and fly south to pass the winter. South of Egypt, away across the deserts, the Sudan and East Africa provide good winter quarters for incalculable numbers of birds.

Barren Zone.

Between these two great areas of the birds' summer and winter activities there is then a wide belt of the earth's surface where it is not only impossible for them to pass the winter, but impossible for them to find any food, drink, or cover. For hundreds of miles to east and west this inimical zone is crossed by a single thread of vegetation, the Nile Valley. The space between the Nile and the Red Sea is occupied

by a barren limestone plateau; on the west a vast undulating area stretches without plant, animal, or insect life, until it merges in the limitless desolation of the Sahara. Between the oases it is possible to travel for a hundred miles without setting eyes on a single scrap of living vegetation. From Cairo southwards the width of the cultivation nowhere exceeds ten miles.

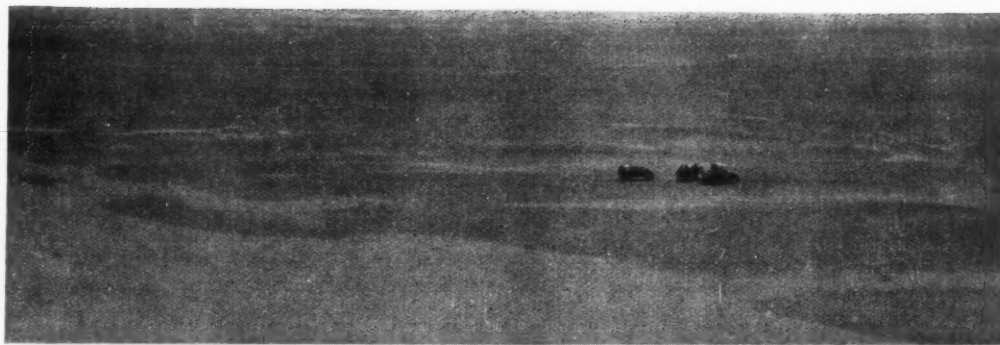
Early Return.

Towards the end of summer a flood of life from the Arctic Circle to the Balkans begins to ebb into Africa. I say "towards the end of summer" deliberately; for it is one of the remarkable facts about the migration in this part of the world that large numbers of birds arrive from the north before the last week in August. The very first to appear are usually the blue and red kingfishers, first cousins of our own bright bird, and they may be seen as early as the fifteenth of the month. But before August is out every sort of passerine, and cuckoos, hoopoes, rollers, and a host more are landing on the north coast of Egypt. It is possible to believe that some of them breeding in the farthest north, the swallows from the shores of the White Sea, or the willow-warblers from the edge of the tundra, may have felt the hint of cooler nights and, possibly, a diminution in the supply of insect food even thus early in the year's decline; but it is a mystery why such a bird as the kingfisher, whose streams have certainly



A CANYON IN THE EASTERN DESERT.

[Photo by Moreau.]



THE FEATURELESS WESTERN DESERT
viewed from the top of a sand-dune. The air is thick with blown sand.

[Photo by Williams.]

nowhere begun to freeze, or the pintail, or the hoopoe, which does not range very far north, should flee south when Europe must, one would think, still be reasonably comfortable for them, and Egypt, for human beings at least, is still distressingly hot.

River of Birds.

It is by way of the narrow strip of life-giving vegetation provided by the Nile Valley that the summer bird population of a large part of Europe has commonly been considered to pass. It is much as though the North Sea tides, instead of running more or less freely through the Straits of Dover, were set to pour through a gut a hundred yards wide. Immense as the number of birds involved in this seasonal tide of migration is shown by this comparison to be, yet the multitudinous movements to be seen in the Nile Valley are striking enough to have justified the theory. The spring migration starts early in March and continues till the beginning of June; the return movement extends from mid-August to the end of October. Throughout these months new species arrive every day, and some specially abundant forms may be seen flying over all day long and day after day. At these seasons the strange far-carrying whistle of bee-eaters, both European and blue-

cheeked, sounds overhead from dawn till dusk, and often in the hours of darkness. Flocks of short-toed larks succeed one another continually hour after hour and week after week. In October the white wagtails, skylarks, and pipits travel south in such abundance that before one party is out of sight another has come into the range of vision. The gardens swarm with an ever-changing throng of small birds fond of leafy cover. In spring, wrynecks, the whitethroats, redstarts, subalpine warblers, Ruppell's warblers, to mention but a few of them, are everywhere in the foliage. In autumn shrikes, ortolans, flycatchers,



MARSA MATRUH ON THE NORTH-WEST COAST,
showing the arid conditions at the end of summer.

[Photo by Banfield.]

and willow-warblers are among the commonest passers-by. None of these birds winters in Egypt. All pass straight through.

It is a curious fact, never yet explained, that some species occur in immense numbers at one season, like the nightingales and the lesser kestrels in spring, or the red-backed shrikes and willow-warblers in autumn, and are never seen in Egypt on their return passage. Whether on their return they pass over Egypt beyond the range of vision, or whether they travel between their summer and winter quarters by a different route altogether, and why they should act thus at the two seasons, no one knows. It is true that the observers of birds in Egypt are, and always have been, extremely few. The native inhabitants take not the slightest interest in this or any other branch of natural history. At the moment there are probably not half a dozen people in the three quarters of a million square miles comprising Egypt who are regularly on the look-out for birds, and even those few will be along the banks of the Nile. Nevertheless, the presence or absence of these various species at the different seasons are so insistently obvious to the most careless observer that there is little doubt of the correctness of the conclusion. Most days in March or early April one may catch sight of a lesser kestrel coming up against the steady north wind. The eye is led to pick up another and another and another, till the entire sky is seen to be speckled with lesser kestrels. Their mode of progression is peculiar and unmistakable, curving and circling, with scarcely a wing-flap, an effortless edging into the eye of the wind. At the same season the long, loud, uninflected squeak of the nightingale sounds from every patch of cover, and in the early mornings you may hear snatches of the well-known song. In the autumn these birds are neither seen nor heard. On the other hand the shrikes are hawking from many a point of vantage, every wire and twig in some localities. If any abundant movement of these birds took place at the time of the return passage it is inconceivable that it should go wholly unobserved.

Clangor of the Flocks.

Apart from the sense of grandeur irresistibly conveyed by the mere magnitude of the migrations, and the exquisite beauty of a flock of bee-eaters in flight or a roller at rest, migration time in Egypt is productive of strange and wonderful thrills. Some days in the year you are startled in your house or tent by a medley of faraway trumpet notes, a sonorous babble made musical by distance. It is the cranes. Sometimes these great birds fly so high as to be almost

out of sight, but yet their clangor is clearly audible on the ground as a mysterious noise that is strangely heart-stirring. Often they travel in myriads, so that they appear as a broad band of specks sweeping half across from one horizon to the other. But in all my experience nothing can exceed in wonder a flight of pelicans on a big scale. I have seen them so high in the air and in such huge numbers that they looked first of all like smoke and then, through powerful binoculars, like a cloud of gnats. Nearer to the earth they show as dainty patterns of rose-pink and black with rigidly outstretched wings. For these quaint unwieldy birds are capable of soaring as grandly as an eagle. Phalanxes of them, each moving as one creature, glide over and under one another as if consciously forming the most beautiful of designs on the background of cloudless blue sky.

Desert Concentrations.

Enough has been said to show that the migration phenomena in the Nile Valley are stupendous. Now, since the banks of the river are the only parts of the whole of Egypt which are readily accessible or commonly visited, it has generally been accepted that twice a year the Nile Valley is the scene of a great concentration of birds seeking to cross the desert zone, and that nowhere else in Egypt can such a strong current of bird-life be witnessed. Practically no bird work has been done in Egypt outside the Nile Valley, and what goes on in the deserts or on the coasts other than that of the delta, is unrecorded, if not unknown. In several years' residence here I have been fortunate enough to visit various places on the north coast from Tripoli to the Palestine frontier, to gather some slight acquaintance with Sinai and the interior of the Eastern Desert and, finally, to visit in spring the Western Desert oases of Baharia, Kharga, and Dakhla. Everywhere the same birds that are so prominent on migration in the Nile Valley have been seen in abundance. My own observations have been supplemented by occasional notes kindly given me by Egyptian officials whose work has lain in the deserts. Every addition to the information points to the same conclusion, namely, that wherever you go, in the remotest parts of the deserts, you never fail in spring and autumn to meet with migrant birds. This is true throughout the length and breadth of Egypt. For instance, quail, the migrants of most "economic" importance in Egypt, are watched for as keenly and netted as plentifully by the Sinai Bedawin as by the Awlad Ali of the extreme north-west. At the same time, though the volume of migration as a whole may

approximately be equal on all longitudes, it is clear that individual species are not equally represented on all lines. For instance, the blue-headed and black-headed wagtails are rarely seen in the Nile Valley at any season, but a copious movement takes place farther west. Even in the terrible desert north of Baharia, I saw during a rapid journey by motor from the oasis to the coast, swallows, harriers, kestrels, larks, bee-eaters, and blue-headed wagtails. Such instances could be multiplied. A torrent of birds strikes the north Sinai coast in autumn and appears to pass down the length of that barren peninsula.

Unknown Flight Lines.

Finally, in the oases there are wonderfully numerous passages of all kinds of birds. The natives, whose range of interest is of the very narrowest, are alive to these seasonal movements to the extent of setting traps for succulent ground-haunting birds like the larks and wheatears. Dakhla is, from its position, the oasis where the scantiest migration might be expected. In an hour one April morning at the wells called Abar Meyhub, the extreme north-westerly point of the oasis, where there are a few cornfields and a patch of acacias, my wife and I observed redstarts, Bonelli's warblers, swallows, housemartins, sandmartins, flycatchers, hoopoes, wheatears, russet chats, a wryneck, a sedgewarbler, and a harrier.

It may be suggested that the birds encountered in the deserts must be merely lost stragglers, or that the migrants cross the Western Desert by tacking from one oasis to the other. There is no space here to set forth the arguments against such a belief, but I think they are conclusive. By the way, a word of warning is necessary in connection with these oases. They bulk large on the average map, because they are situated at the bottom of extensive depressions. Actually, of the area marked "oasis" or coloured green on the maps, not more than one-hundredth in the case of Baharia, or one-tenth in the case of Dakhla, is under vegetation.

It is contrary to all our preconceptions when we find that birds travel southward and northward regardless of, and one might almost say reckless of, the length and unbrokenness of the desert journey such a course involves. Birds moving on different lines of flight are faced with very different tasks. Some land on the shore of the delta, so that the Nile Valley, a safe and easy route, coincides with their line. Others farther west, fresh from a four-hundred-mile sea-crossing, plunge forthwith, perhaps without descending to earth at all, into a desert-crossing three times as long and not less dangerous in its hazards.

Apart from the insignificant oases no water, no food, not a leaf, not a rock for shade, exists for twelve hundred miles. Whether any considerable volume of birds migrate due south across the worst desert of all, beyond Dakhla, is yet to be ascertained. Meanwhile we can only speculate on the mortality which the desert crossings must inflict on the birds attempting them, and theorize on its effect in the survival and evolution of species.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

THAT the value of the work carried out at the Imperial College of Tropical Agriculture in Trinidad is appreciated throughout the Empire, is shown by the steadily increasing list of donors to the special appeal now being conducted by the Duke of Atholl during Lord Burnham's absence abroad.

Recent donations and promises include £500 from Platt Bros. & Co. Ltd., £100 each from The Sun Life Assurance Co. of Canada and the United Alkali Co. Ltd., £50 each from Ransomes, Sims & Jefferies Ltd., James Kenyon & Son Ltd. and £20 from Stubbs & Grindrod.

Contributions may be sent to Mr. Algernon Aspinall, C.M.G., Secretary, 14 Trinity Square, London, E.C.3, or to the bankers of the fund, Barclays Bank (Dominion, Colonial and Overseas), 30 Gracechurch Street, E.C.3.

THE TRANSPARENCY OF NEW-LAID EGGS.

By holding an egg between the eye and a 50 c.p. metal filament lamp (or a similar light), it is possible to tell its age to within twelve hours. A newly-laid egg, less than an hour old, appears uniformly transparent, except for a few dark spots here and there due to inequalities in the shell. Twelve hours afterwards, however, lighter patches appear, and the egg looks more or less blotchy near the "ends" (the "top" and "bottom"). These patches are more or less blurred in outline. As time goes on they increase in definition and number and are more easily seen from twenty-four hours of age onwards. Recent research shows these patches to be due to the hygroscopicity, or affinity for water, of certain parts of the shell. Water is absorbed and transparent patches are formed. Other parts of the shell, on the other hand, lose water by evaporation, and so become more opaque. The formation of the blotches is prevented by keeping the eggs in an atmosphere saturated with moisture.

Ostia, Rome's Ancient Port.

By Alice M. Ashley.

Recent excavations at Ostia have brought to light many interesting finds. These may not be of supreme archaeological importance, but they are useful in helping us to build a picture of the domestic life of the time.

ROSES, poppies and honeysuckle clothe the ruins of ancient Ostia. The shadows of the white columns fall across the sunlit pavements, and the guide reaches up to pull the clusters of honeysuckle to fill the arms of the tourist. How much better that the life of the ancient city should be associated with brightness and warmth, rather than with the dark gloom and decay which the word "ruin" suggests to so many minds! In early days, when one arm of the Tiber still flowed past the store-houses and granaries of the town, the gleam of the water must have added a further beauty to the scene. In those days, before the coming of the malaria, the now deserted Campagna teemed with sturdy life; farms and gardens, the luxurious villas of the wealthy, lay each side of the road to Rome, and along that road one can imagine a never-ceasing traffic of chariots and wagons, of riders with the imperial mail, of ladies litter-carried, paying calls of ceremony upon their stately neighbours. Merchants also, and slaves from Syria and the farther East, and sailors, and Jews, and priests of Isis and Cybele, all mingled with the throng. And now beneath the sun the wide Campagna lies abandoned. No one can prophesy whether again the land will be filled with human life. Though as yet there is little sign of prosperity the modern sanitary officer has already begun to win a victory over the dread disease, and perhaps the thousands of vigorous Italians, now debarred from seeking their fortune in America by the fatal news that the "quota is full," may turn their energy to the reconstruction of prosperity in their own land.

Business Community.

It was between the third and fifth centuries after Christ that the greatness of Ostia, as the port of Rome, reached its high-water mark. There was at this period, throughout the cities of the Roman world, a mania for leaving engraved upon stone a record of one's life and public service. Thus it is that hundreds and thousands of inscriptions have come down to us, from which the modern historian has been for the last fifty years reconstructing the social history of the empire. From Ostia alone several thousand inscriptions have been deciphered. From them we may gather a pretty clear impression of life in an ancient commercial city, a community largely lower and

middle class, mercantile in character, not without very strong artistic and religious interests, but distinguished rather for the picture which we can create of its economic and social life. It is for their contribution to the economic and social history of Europe that the excavations at Ostia are of peculiar importance.

Modern Parallels.

Archaeologists are now busy supplementing and modifying knowledge gained at Pompeii. This is particularly true with regard to the typical plan of the Roman house. Hitherto we have been guided chiefly by Pompeii and have imagined the Roman house as constructed round an open court, looking entirely inwards, and displaying to the street bare walls unadorned by windows and balconies. This was the type of house built for the dwelling of a wealthy man in a country where sunlight is to be avoided rather than courted; the inner quadrangle with its shady porticos provided a pleasant place where the leisure summer hours could be spent. But now the article on the Roman house in the standard dictionaries of antiquities will have to be rewritten, for the Ostian house conveys an entirely different impression. Here we find clear evidence that lofty buildings bordered the city streets, buildings probably only too like the modern apartment house. In many cases, as in modern times, shops and warehouses formed the lowest story, and above them were the flats; sometimes a stairway led straight from the street to the second floor. The outer wall of these high houses was provided with rows of wide windows and with balconies overlooking the busy thoroughfare below; the house looked outwards, not inwards as at Pompeii, for in a busy commercial centre space is too cramped to allow of inner courts. An impression of surprising modernity is conveyed by these blocks of houses, an impression further strengthened by the broad straight thoroughfares. At Ostia, as at the equally remarkable Roman city of Timgad in Algeria, these streets are obvious proof of town planning, monotonous perhaps, but the sign of intellect consciously bestowed upon the development of a city. There may be, no doubt, a loss in quaintness and charm in comparison with the cities of the Middle Ages, but one hopes that there was a compensating gain in the healthy con-



THE STATUE TO AN OLD-TIME
BENEFACTOR.

ditions of life which foster a lively and independent citizenship.

Discoveries.

I shall make no attempt here to describe in detail the progress of the excavations or the arrangement of the buildings which have been brought to light, but before going on to any discussion of their artistic, religious, or economic importance, it may be interesting to note in passing the vast divergence in aim between the excavators of a hundred years ago and present-day archaeologists. The antiquarians of a century ago were aiming at the discovery of works of art, and in this their success was remarkable. But too often they took no interest beyond the narrow limits of their search; the more general historic and economic questions, on which their excavations might have thrown light, had not then been raised. If a statue was discovered in a house, that was sufficient to be thankful for; the rest of the house was disregarded, was often covered over again or actually demolished. But nowadays, since the birth of economic and social history, no brick is too insignificant to escape notice. The tiniest indications are traced which may help us to picture the actual conditions of life in past ages.

More than a hundred years ago excavators at Ostia were successful in disinterring some very fine specimens of Greco-Roman art. These are now scattered among the museums and art galleries of Europe. There are three examples of Ostian art in the British Museum, one at Lansdowne House, one in the Louvre, several in English country houses and a considerable number in the Papal galleries. The "Townley Venus," one of the treasures of the British Museum, comes from Ostia; so does a Juno, found in the beautiful "Palace of Gamala," and now in the Vatican. Another impressive statue found in the Ostian Baths is supposed to represent the Empress Sabina, and a lovely winged Athene still stands on guard by the city gate.

Almost more interesting than the statues, because showing more individuality of style, are the beautiful mosaic pavements which adorn the Baths.

Pavements.

The "Neptune and Sea-monsters" is a glorious piece of work which alone would be full recompense for the trouble of a journey across the Campagna. There is a quite wonderful feeling of life and energy in the spirited representation of the monsters of the sea.



AN IMPERIAL STATUE,
headless, and still unidentified.



OIL OR CORN JARS SET IN THE GROUND AND USED AS
GARDEN ORNAMENTS.

The wild vigour of the horses seems inspired by something which belongs not to this world, and suggests that they are indeed the divine horses of another element. It is true that the artist has shown a curious inaccuracy of detail. Though the horses have reins they draw no car. The right leg of the central figure is unfinished at the knee. But such imperfections in detail are more than outweighed by the energy of the whole composition, and by the vigorous fancy which devised and executed the host of strange monsters, the unicorns and sea-tigers, the cupids and the dolphins, which gambol round the god.

The wall-paintings at Ostia are in general inferior to those at Pompeii; but there is perhaps one exception—the delightful "Children's festival" in the Vatican library. Here, on one panel, we see a tiny Artemis up-reared on a pedestal, round which are grouped a company of children in the attitude of worshippers, while others carry in procession baskets of fruit and clusters of grapes.

Bakery.

On the companion panel is shown the little model of a ship drawn by two children on a small two-wheeled cart. Other children stand in a little group chatting together, and one who holds a flat dish in his hand seems to be taking a collection! The scene apparently was suggested by an annual ceremony early in spring, when the populace of Rome poured down to Ostia to view the launching of a ship sacred to the Egyptian Isis.

But the artistic survivals from Ostia are not limited to statues, mosaics and mural decorations. Among the most recent excavations are the ruins of a large bakehouse, which was evidently destroyed by fire some time in the third century; here, among machines for crushing grain, troughs for kneading bread, and enormous ovens, have been found a large number of small bronze figures. Some of these are little statuettes such as one might have on one's mantelpiece nowadays. There are also ornamental candelabra and vase handles

and other little objects which probably belonged to the upper rooms above the bakehouse, perhaps to the miller himself; they show real merit as works of art, and seem to indicate that artistic appreciation was not limited to a few men of leisure but extended to the mercantile middle class. That the citizens did in fact display a generous interest in the adornment of their city is fully proved by many inscriptions which tell of public-spirited beneficence. Of one millionaire it is recorded that he provided for the restoration of seven temples, the paving of a street near the Forum, the putting up of the public scales in the market and, moreover, paid a tax of forty thousand pounds out of his own pocket to the municipality. His

interests, as it seems, were not only artistic and religious, but had utilitarian ends in view.

Banquets.

We are told of the same genial plutocrat that on one occasion he gave a public dinner to two hundred and twenty-seven of his fellow-citizens, and on another occasion paid for a luncheon to which apparently the whole community was invited. No wonder he was popular, and no

wonder that upon his death a golden statue was erected in his honour.

The vast majority of inscriptions from Ostia, as from elsewhere in the Roman empire, are sepulchral "tituli," that is, records of a man's name and civic career inscribed above his grave or near the place where his ashes were preserved. Few though the words may be, they are yet of incalculable value to the student of social history. Among the many official positions held—and there is always a tendency to multiply offices among a people who have a natural talent for organization—there are at Ostia innumerable references to priesthoods held by citizens, prominent or obscure; and this brings us to consider the contribution of Ostia to the history of religion, an aspect of the subject which receives but scant attention in most accounts of the place. The greatness of Ostia



MOSAIC PAVEMENT,
showing Neptune in his four-seahorse-power car, attended by sea monsters.

falls largely within the period when the old Roman beliefs and forms of worship were losing their hold on the popular imagination, and were being replaced by the more emotional religions brought from the East, Christianity among others. Mithraism and Christianity were of eastern religions the two which appealed most forcibly to the western mind, and there were periods when it seemed possible that of the two Mithraism would be the religion of the future. By the third century, moreover, the racial constitution of Italy had been greatly modified owing to the gradual manumission of vast numbers of slaves from the East. At Ostia, therefore, a port with a large foreign population, it is not surprising that we find evidence of many varieties of religious faith. Side by side with the long-established worship of the Olympian deities, and with the newer cult of the emperors, the ceremonies connected with the names of Cybele, Attis and Mithras, from Syria, Egypt and Persia respectively, were in general use; we find also Judaism and Christianity.

Chapels.

Temples and shrines built by the adherents of every type of faith existed at one and

the same time and within a few hundred yards of each other. The religious life of Ostia must have been not unlike that in a modern city, where the members of one family may choose on Sunday morning between attendance at their parish church, at a Unitarian, Baptist or Methodist place of worship, a Friends' meeting, a Christian Science temple, or the haunt of the Theosophists! Or they may even refrain from church attendance altogether. Thus at Ostia the older, as it were, "established," forms of worship remained in use side by side with the newer more enthusiastic cults. The official religion, so to speak, of the community was associated with the temple of Vulcan, and the high priest of Vulcan held a position of quite unique importance. Apparently his authority extended, at least nominally, over all the temples of the town, and inscriptions record that his permission was required when statues were erected even in the sanctuaries of Serapis and of Cybele.

The priesthood was held by men of high senatorial rank, and was apparently one of the most honorable distinctions which could be obtained during a man's public career. One may imagine therefore in an Ostian family some such diversity as this: the father a respected priest of Vulcan; the wife, with the indulgent permission of her husband, attracted towards "Serapianism"; the elder daughter, influenced perhaps by a Syrian nurse, a worshipper at the shrine of Cybele; the younger daughter with a secret interest in Christianity (not necessarily secret, by the way, as there is little trace in the provincial towns of the persecution practised at certain periods in Rome); the son, during his military training, paying a perfunctory service at the altar of Augustus in the regimental chapel behind the barracks, later, perhaps, turning to the purifying rites of Mithras.

Cults.

We have in Mithraism by far the most important of the eastern religions, other than Christianity, which spread through western Europe under the later empire. The Mithraic chapels and the sculptured symbols of the cult are always distinctive. The "Mithraeum"



OSTIA
A scene at the excavations.

was usually underground, a small room accommodating not more than about fifty worshippers. The division into sanctuary, nave and choir is constant, and the slightly-raised platform on which the worshippers probably knelt is peculiar to Mithraic chapels. At the end farthest from the entrance there was always a sculptured group, representing Mithras slaying the bull. No less than six such chapels have been found at Ostia. Here the faithful gathered for worship, and for the mysterious initiation ceremonies, the nature of which we can only guess. Certainly there was some rite corresponding to baptism; the initiates shared in a sacramental meal, and the shedding of blood symbolized the sharing of the life force and the redemptive power of sacrifice. Such ideas and ceremonies were common to most of the so-called "mystery religions" of the East. The peculiar strength of Mithraism lay in the fact that in it and in Christianity alone sacramental and ethical teaching were combined.

The faithful were taught that by their own efforts, by purity and by a severe discipline of life, they might secure heavenly peace hereafter. Some place being left for free-will, Mithraism did not partake of the fatalism of the East, and this religion therefore won the adherence of the soldier, and of the more virile elements in the population of the empire, and it alone is worthy to be compared in any sense with Christianity for the purity and strength of its ethical teaching.

A thorough survey of the economic aspects of Ostian life would be here impossible, but any account of the city would be incomplete without some reference to the trade associations which played so large a part in the social life of the lower classes. The existence of such societies is proved by many inscriptions: among others we hear of guilds of naval engineers, ship-masters, and divers; wine-dealers, oil merchants, and corn measurers; builders, bakers and fishmongers; furriers and rope-makers. These associations were not trade unions in the modern sense of the word, for their objects and interests were very different. It is exceedingly unlikely that they ever aimed at the raising of wages or the improvement of conditions of work. They made no attempt to develop craftsmanship or to restrict the number of apprentices.

Friendly Societies.

Their function was rather to satisfy the natural human craving for companionship in joy and sorrow, and thus their two main activities were the provision of social gatherings and the conduct of funerals. They combined the duties of a burial club with the more cheerful occupation of organizing supper-parties. The birthdays of past members were considered a fitting occasion for merry-making, and the inscriptions record many a legacy left with this end in view. No doubt these societies gave scope to that love of competent management which was characteristic of the Roman. Even small clubs were provided with a whole hierarchy of officials, grand in title, though their functions probably amounted to little more than the collection of monthly dues, the exaction of fines, and the more popular duties connected with the evening festivities. Honorary adjectives abounded: Ostia, for instance, boasted in a "*splendidissimum corpus suppatorium*," which we may perhaps translate as a "worshipful company of rope-makers."

In Ostia, again, we find an almost unique example of an ancient "corn exchange." Behind the theatre, and not far from the middle of the town, is a wide rectangular space surrounded by a colonnade; in the centre are the ruins of a shrine, commonly called the "Temple of Ceres," though there is as yet no clear

proof of its identity. Here the business men of Ostia met to discuss their affairs and here, behind the colonnade, were a number of small rooms or offices, each probably the headquarters of a separate shipping concern. The association of these offices with companies carrying on trade by sea is not a mere speculation, for the mosaic pavements are still intact and here we may see the trade-marks, and in some cases the names, of all the more important firms. The emblems used are most suggestive: among others a lighthouse, an elephant (denoting trade with an African port), a corn-measure, a wine-measure, palm trees, a mermaid on a tiger, dolphins and, in many cases, fishes and ships. From the names which occur we gather that the companies were concerned especially with the North African trade, the source at this time of the major part of the Roman corn supply. The impression conveyed is one of a highly-organized system of importation and distribution, for it was after all as the controller of the bread of Rome that Ostia made its peculiar contribution to the history of its country.

ACCELERATING CORROSION.

If a rubber band be wrapped rather tightly round a piece of soft iron and the whole left in dilute hydrochloric acid for some weeks, the iron is found to have become pitted beneath the rubber. The acid, in fact, acts much more rapidly within the capillary spaces between the metal and rubber than on the exposed surfaces. The corrosion is more or less electro-chemical in its nature, and the small distance between the band and the iron favours the production of electro-chemical action with the result that the iron immediately in the vicinity is corroded at a more rapid rate than where the action is not so localized.

RADIUM TO TIME THE BLOOD FLOW.

THE latest use to which radium has been put is to show the rate of flow of blood in the veins. The method adopted was to put the animal used in the experiment into a lead box with one foot sticking out of a hole in the side. A solution of salt in water, to which was added a small portion of a radioactive compound of radium, was then injected into a vein in the animal's ear. The time was noted and a careful watch kept on an electrical device attached to the foot. When this device revealed that radioactive rays were given off from the foot the time was again noted and the difference between the two times gave the rate of flow of the blood from ear to foot. All we can say is, whatever will they do next?

Tweed, Sheep and Tartans.

By Miss M. G. Best, F.Z.S., M.B.O.U.

The chemist has brightened our lives with a splendour of coal-tar colours, but there is still a small industry in hand-made yarns dyed with natural colours drawn from rock lichens and plants. Few folk know that the now popular Fair Island designs are a heritage of the Spanish Armada.

THE art of dyeing wool from vegetable dyes was practised in Scotland from days of so long ago that no written records were kept of the proceedings, and knowledge of every description was handed down from mother to daughter, or mistress to maid.

The dyeing of the wool seems always to have been done by the womenfolk, while the men as a rule did the weaving, after all the spinning had been done for them; for one could see that hands roughened by hard manual labour would not be conducive to even spinning.

Dyes.

To-day, in those parts of Shetland where the women spin the yarn as fine as the thread of a spider's web, they do no hard work on farms or gardens that would roughen their hands.

It is very difficult at the present time to find out anything about the dyeing—except that which is still practised from the common lichens, on the rocks, the heather, and other local plants. Prizes for wool dyed in different colours are offered at the various Highland gatherings, and these competitions are reviving interest in many districts. The older women are trying to remember little hints they heard from their mothers or grandmothers, hints as to the water to be used, whether rain water or from the spring on the hill, if hot or cold, etc.

One begins to realize oneself after trying a few experiments that a great deal of the success or otherwise of the result in the dyeing is due to the tiny details in the boiling—just whether the materials for the dye are boiled quickly or slowly, and at

what stage in the growth of a plant it is gathered, and what part of it is used—and it is just these sort of details that are so difficult to get hold of, and information on such points needs much searching for.

Tartans.

It is a curious fact that home dyeing is almost, if not entirely, practised north of the Tweed; probably very little was ever done in England.

The Scotch people had their incentive in the variety of hues used in the tartans worn by the clans, and these gave a very wide range of colours to produce. It is obvious that the tartans—as we know them in the present day—must be very different from those made from vegetable-dyed wools that were originally in use. That of the Stuarts, for instance, would have been far softer in colour than that now produced from a chemical dye, which is gay to say the least of it. But how the original red was obtained seems to be a lost art, though in one district in the Highlands the women claim to have produced a red, and the secret is most jealously kept.

The most common of the dyes in use in the Highlands



A CROFTER WOMAN AT WORK WITH HER SPINNING WHEEL.

at the present time are obtained from the lichens, or "crotals" as they call them in the Gaelic, which grow on the rocks by the seashore just above high-water mark. A dark brown almost black lichen gives a lovely range of shades from a brilliant orange-yellow to dark brown, depending on the length of time the wool is left in the dye. With so many of the plants it is necessary to "mordant" the wool first. This is done by boiling it in a weak solution of either alum or bichromate of potash, which enables the wool to take the dye. But with the black lichen no previous preparation is necessary, though a little copperas may be added if a very dark colour is required.

Heather and Indigo.

We were talking to a Highland weaver one day, asking him for information as to the use of certain plants—a gentle dreamy old man who had lived for many years in the same solitary cottage. He lives alone now his sisters have gone. It was they who used to dye his wools for him, and very lovely they were. But now that he has to buy them ready dyed the colours are very different, and much of the charm of his webs of tweed has vanished. He mentioned the green, which is a favourite colour with them, and the main part of so many tartans. He told us that the wool must first be steeped for a few days in water tinted with indigo to the "colour of summer water. Then gather your heather from the shady side of the hill, and boil your blue wool in that to get the green."

The old man seemed to weave so much poetry and romance into his tweeds with the different shades of wool he used, and even in the gathering of his plants.

The difficulty that most home dyers have to contend with is the limited size of their receptacles, so that they can only dye a certain quantity at a time and find it practically impossible to repeat the same shade on another occasion. Therefore the wool is dyed before spinning—first dyed, then carded, and then spun. When the wool is carded, it is passed between two flat boards studded with fine wire pins, when all the rough bits and tangles are removed, and the wool is left fine and soft. During the carding it is easy to mix in all sorts of different shades, for if you examine a woven thread there are many flecks of different colours to be seen, and it does not matter if there is a slight variation in the successive dyeings of the main colour, as they are mixed together when carded.

In the Shetland Islands there is very little if any dyeing done at all. The native sheep are of four different colours—white, grey, morit or fawn, and

brown. All their knitted woollen garments are made with one of these colours, with a pattern of some of the other shades around the edges of jumpers or shawls.

The Fair Isle work, with its intricate patterns of many-coloured wools, is said to be a tradition handed down from one of the Armada ships that was wrecked there. In this instance history supports the story of the Spaniards on Fair Isle. But it would be hard put to it to account for the number of Armada ships that were said to have been lost in these waters. Anything that cannot be accounted for in any other way is attributed to another of these naval disasters, even to a larger breed of ponies that is found on one of the islands. Whatever secret the people of Fair Isle may hold in regard to the production of their dyes, they are very careful not to let it leak out. But one thing is certain—the Fair Isle colours have a reputation of keeping clean when washed, while others manufactured elsewhere are inclined to "run."

In the Shetland Isles the chief industry is knitting. All the women knit, and very little weaving is done. Nowadays a good deal of the wool is sent away to the mainland to be carded and spun. It is then mixed with some other wool to make it go further, as the supply of real Shetland wool is very limited. But this machine-spun is a very different thing from the hand-spun wool the Shetlanders spin themselves.

In the early summer their tiny sheep are rounded up and plucked, not shorn; for the under fleece is by this time so far advanced in growth that it is only possible to pull the old wool off as if they were plucking a chicken. The heather has probably done a good deal of this already, as wherever one goes tufts of wool are to be seen caught in the rough growth on the hills.

Spinning the Wool.

The wool is brought into the house and left for future treatment; for in the summer time every advantage is taken of each moment of daylight. Why should one go to bed when it is light enough at midnight to play golf? They make up for it in the winter in those northern isles, for it is dark by four o'clock, and the evenings are very long. But then the Shetlanders have time to tackle many problems, the wool question among others; and spinning wheels are taken to a neighbour's house where the wool is spun, and the spinning songs are sung, old songs handed down with the art of spinning from very ancient times, and which are sung to the accompaniment of the hum of the wheels. These

winter gatherings are of great value in this, that by their means the old songs, legends, and stories are remembered and related by the older members, and so are handed on from one generation to the next.

In the South of England one comes across the same sort of meetings on the occasions of the "Quiltings," when a housewife, having completed a large patchwork cover, lined it with feathers or shreds of material, or whatever she might find, called her friends together to help her stitch or quilt the cover all over.

The Shetland women seem to knit by second nature without conscious thought. One sees them starting forth from their crofts with a creel on their backs, to gather peat from the hill. Round their waists are twisted the knitted parts of a jumper or shawl, while they are busy knitting on the remainder, knitting as they walk—and this not on made roads, or even tracks across the moor, but over the rough moor itself, with its tussocks and holes, traps set everywhere for unwary feet. A good deal of their knitting is collected in the big shops in Lerwick and

sent away as required. The manufacturing towns of the North of England take most of their small shawls, where the older women wear them over their heads.

An Export Trade.

A visitor is, however, always fair game, and it would be hard to say how many knitted garments of one sort or another we were not offered during our stay there. One day I was sitting on the quay at Lerwick watching the gulls in the harbour, when a woman came up, and after standing there for a few minutes, began with:—"Ye have come from the South?" Then, more confidently, "Ye'll be wanting a shawl. I have one, a nice grey with a black pattern on it, just the thing for an old lady."

Away in the Outer Hebrides, and all down the west coast of Scotland, the chief industry is the weaving. Stockings they will knit, sometimes those with the wonderful patterns to be worn with the full dress tartans; some, I have been told, taking twenty-five balls of different coloured wools to work the pattern out, and all in use at the same time.

Cottage Looms.

In most of the tiny whitewashed cottages on those outer islands one finds a loom with a web of tweed set up on it. The only light in the room filters through a small murky window, and in summer time by the door also. But in winter the room would be, in addition, full of the smoke of the peat fire. It is only in comparatively recent years that any of the crofts boast chimneys. The country-folk greatly resented them when they were introduced, saying they were much healthier without them.

The bales of tweed are brought down to the local merchant, who sends them to Glasgow or Oban or even



BLACK-FACED HIGHLAND SHEEP,
whose wool makes the most admirable yarn.

farther afield. These hand-spun tweeds are worth a good deal of money. Sometimes a message would be brought to us that a relation of one of the maids had arrived with a short length of tweed which they were sure we should like to see and, of course, we were glad to buy it of them. The tweed met with more success than the Shetland shawl, but it may have been more tactfully presented!

In some places the crofters have the right to run a certain number of sheep on the moors. This is all very well in the summer when there is plenty of grass and young heather; but there can be very little to feed them on in the winter, and the condition of many of them in the early spring is deplorable. Where the crofters have enough grassland to make a little

hay, or a patch of ground where they can grow a few cabbages, they consider themselves very well off; the soil is so poor, so much of their "arable" land is not soil at all, only rocks, round which the plough wanders on its way up and down the tiny fields. Therefore their crops are bad; they can hardly gather enough corn for themselves, and have certainly nothing for live stock.

Wind-battered Islets.

To be sure, on those outer isles the winds make it impossible to grow anything more than a few inches in height. A walled garden seems very little better than an open hillside, as the wind tears round and round inside and damages the plants. One such garden I knew, which boasted one currant bush, the pride of its owner's heart. All might be well with that bush for a few days, then would come a gale of wind, which caught the bush, twisted it round with a rapid circular motion till the surrounding soil was loose, and lifted it bodily out of the ground. The bush was retrieved and replanted, and the little game repeated probably the following week.

It says a great deal for the patience of the owner and the perseverance of the bush, for although it had no time in which to develop any fruit, still it was green with remnants of battered leaves.

Where the country is a fertile one, like the borders from Carlisle to Berwick-on-Tweed, sheep run in their thousands all over the hills. Here many breeds are introduced to improve the local flocks both for mutton and wool. But the Highland blackfaced sheep are met with everywhere; their rams are extraordinarily

handsome fellows, with their clear amber eyes and beautiful twisted horns. These sheep carry a tremendous fleece of wool, cut off neatly a short distance from the ground by the wear and tear of the heather. I have often wondered, if their legs were longer, to what length it would be possible to grow their wool.

When any farms along that Fell country are to let, the incoming tenant takes over a certain amount of the flocks of sheep belonging to the outgoing farmer. It is as much part of the procedure as taking over the farm itself, and for this reason: if sheep new to the country were turned loose on the hills they would wander in any direction at will, and cause endless

trouble to the shepherds who were trying to keep an eye on them; whereas sheep that know the farm will remember their way about, and in bad weather can find their way back to the farm for food or shelter.

Yarn.

The wool of these sheep is strong and firm in texture, admirable for weaving tweeds, rugs, and such-like, and for the knitting of

stockings: a very different thing from the pure Shetland wool which is soft and fleecy as a summer cloud, with a warmth and cosiness about it that is not to be found in any of the wools provided by the larger and perhaps more civilized variety of sheep living, as they express it in those northern regions, "on the adjacent Islands of Orkney and Great Britain."

In the last issue the descriptions beneath the illustrations in Dr. Stephenson's article were unfortunately transposed. It was an obvious printer's error, for which we apologize.



IN THE SHETLANDS THE OLD SYSTEM OF HAND-CARDING IS STILL USED.
The wool is soaked in oil and kept in the tin box seen on the right-hand side.

Bladderworts (Utricularia).

By Robert Gurney, M.A., F.Z.S.

A great deal of work still remains to be done on Utricularia. How the bladders capture the minute living animals is still rather a mystery, but the author suggests that "trigger hairs" are stimulated by the invading insect and that the prey is sucked into the opening by an inrush of water.

THE bladderworts are a most interesting genus of rootless marsh or aquatic plants, the majority of which inhabit the tropics, six species only being found in Europe. All these six have been claimed as British, but it is very doubtful if one of them, *U. bremii*, can be admitted to our list.

Winter Buds.

The European species depend almost entirely upon vegetative propagation by means of winter buds or turions, which are formed in autumn or late summer at the ends of the shoots, and in some species the production of flowers is very infrequent. Writing in 1913, Professor Glück stated that he had only seen flowers of *U. ochroleuca* from three stations, namely, two in Britain and one in Holland, while *U. intermedia*, although flowering with comparative freedom in Switzerland and some other continental stations, has only been proved to have done so two or three times in Britain. In some localities *U. minor* may grow for years without flowering, while in others, such as the New Forest, it produces flowers regularly. *U. vulgaris*, on the other hand, flowers, in England at all events, in most years, though not always with the same freedom. *U. neglecta* and *U. vulgaris* are very closely allied if not varieties of the same species, and both flower freely; but the former rarely if ever sets seed, so that it depends entirely upon vegetative reproduction.

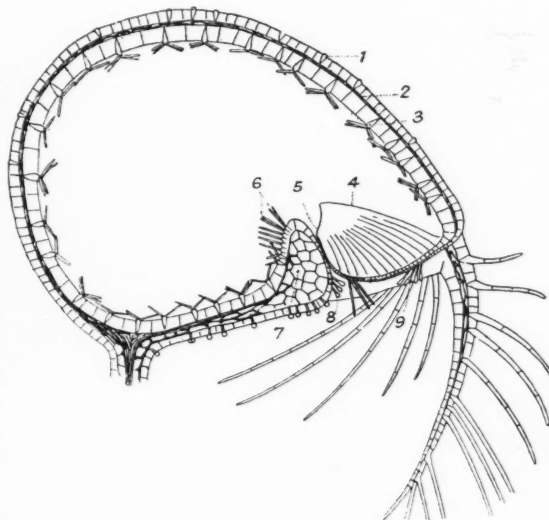
In England some years are more favourable than others for flowering, but what the conditions are which determine good flower seasons or bad is difficult to decide. The fact that *U. intermedia* blooms abroad

so much more often than with us suggests that the continental climate with a late spring and relatively sudden rise of temperature may be the favouring cause. The year 1921 was an exceptionally favourable one for the flowering of all species of bladderwort.

Early in April it was noticed that the majority of plants of *U. minor* examined had already minute rudiments of flower buds, and in June flowers were seen in every locality in Norfolk in which the plant was found. Even of *U. intermedia*, three plants were found in flower on Roydon Common near Lynn, while *U. vulgaris* made an extraordinary show at East Ruston in a place where usually few plants develop flowers. On the other hand, the drought of that year proved disastrous to the plants in many places.

Problems.

The indefinite vegetative propagation of these bladderworts raises the rather interesting, if barren, problem of the constitution of the individual. Miss Pallis* has discussed this point with regard to the reed (*Phragmites*), and comes to the conclusion that a major individual may be defined, but that this individual ultimately suffers senescence and death. It does not seem to me that Miss Pallis' conclusion is in accordance with the facts and, so far as I am aware, no proof has been brought forward of the death of such extensive areas of reed as would be involved. Mrs. Arber† suggests that the decline in the dominance of *Elodea* in this country may be



UTRICULARIA INTERMEDIA.
Longitudinal section of bladder.

1.—Gland cell in outer dorsal wall. 2.—Air-filled intercellular space, containing also a strand of vascular tissue. 3.—Quadrifid absorptive cell embedded in inner wall. 4.—Valve. 5.—Free edge of valve. 6.—Bifid absorptive organs of the "cushion". 7.—Cushion. 8 and 9.—Club cells.

* *Journ. Linn. Soc., Bot.*, XLIII, 1916, p. 251.

† "Water Plants." 1920.

really due to senescence of the major individual, since no seed can be produced; but, though the amazing vigour of its first propagation is spent, the plant shows no sign of senescence as compared with other plants, and still holds its own in competition. For eighty years *Elodea* has multiplied and spread without sexual reproduction, and the mass produced is beyond imagination, and yet all this mass has arisen from one or a few individuals, and the whole mass may justly be designated a major individual endowed with unlimited potentiality and unlimited life.

Immortality.

Similarly every individual of *U. intermedia* at present in existence in Britain has probably been produced by vegetative propagation, and the whole population of the species must belong to a very limited number of major individuals. Yet there is no reason to suggest that its potentiality is approaching exhaustion, and every reason to believe that the major individual is, in this case, immortal.

One consequence of the absence of flowers from *U. ochroleuca* and *U. intermedia* is that the discrimination of the two species is exceedingly difficult. The flowers present some small, but obvious, differences, but in habit of growth and in form of leaf no constant and reliable characters can be defined. Typically *U. ochroleuca* differs from *U. intermedia* in having occasional bladders on its assimilating leaves, and the leaf-segments have finger-like lateral processes bearing spines, whereas in *U. intermedia* the spines are set directly on the edge of the leaf. Further, the leaf-segments are narrow and tapering at the ends in *U. ochroleuca*, while they are bluntly pointed in *U. intermedia*. None of these differences is, however, altogether trustworthy, since in Norfolk, for instance, *U. intermedia* often presents all or some of the characters of *U. ochroleuca*. Bladders are quite commonly found on the leaves; the leaf-segments are generally tapering in spring; also plants have been found in autumn, and have been produced in my aquaria in early summer, in which the leaves had finger-like processes, and would

unquestionably have been named as *U. ochroleuca* if their parentage had not been known. Whether *U. ochroleuca* varies in the direction of *U. intermedia* I am not able to say, but it appears that great caution should be exercised in determining the species.

All the European species fall into pairs—*U. vulgaris* and *U. neglecta*; *U. intermedia* and *U. ochroleuca*; and *U. minor* and *U. bremii*. In each case the two members of a pair are with difficulty separable, but jointly very distinct from the other two pairs.

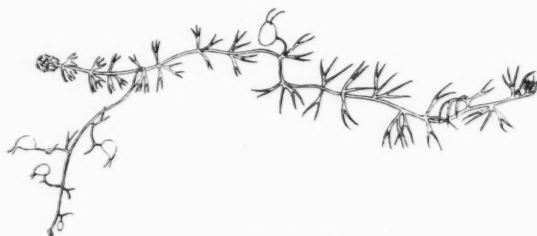
Generally both members of a pair are not found in association, and it seems likely that they may prove to be not really distinct species, but merely alternating forms of one species adapted to different conditions. For instance, *U. ochroleuca* and *U. intermedia* may be the "bog" and "fen" forms respectively of one species.

U. vulgaris, *U. minor* and *U. intermedia* form an ascending scale of specialization of parts. In *U. vulgaris* all the leaves are of the same pattern and bear bladders, while in *U. minor* the shoots which descend amongst moss and mud bear reduced and modified leaves, and these "earth-shoots" not only serve to anchor the plant, but also entrap by means of their bladders species of animals which burrow in mud and moss.

Variations.

In *U. intermedia* the specialization has gone further, inasmuch as the leaves of the water-shoots are usually devoid of bladders, the bladders being produced only by the modified leaves of the earth-shoots. In *U. minor* earth-shoots are not produced at all by

plants which are grown suspended in water, but in *U. intermedia* they almost invariably arise no matter what the conditions may be, although such shoots may, in later growth, develop into ordinary leaf-bearing water-shoots. The same ascending scale is also found with regard to the possession of stomata. These apparently never occur in the free-floating species *U. vulgaris*, and they are generally absent from the leaves of *U. minor*, but they may be present in the latter and are probably always so in examples of the "*platyloba*," or broad-leaved form which is often



Young plant from aquarium, showing one bladder-bearing leaf. Leaves widely separate.



UTRICULARIA MINOR
Eighth leaf from apex of plant from East Ruston; anterior surface, showing bladders.

met with in very shallow water. In *U. intermedia*, on the other hand, stomata seem to be invariably present in the normal leaves, and sometimes even in the modified leaves of the earth-shoots.

One may interpret such a series in two ways. Either we can assume that the free-floating form is the more primitive, and that *U. intermedia* is a late stage in the evolution of a marsh or land form, or the reverse—that it retains some of the characters of the land ancestors from which all have sprung. Generally it is true that water plants have been derived from land plants and not vice versa, but the entire absence of roots even from the seedling of *Utricularia*, seems to point to the reverse history in the case of this genus. The marsh forms of the tropics have underground bladder-bearing shoots which are evidently homologous with the earth-shoots of the aquatic forms, and are easily explained as survivals of an aquatic habit. It is more difficult to believe that such shoots could have been evolved in the first instance on land, or that such structures as the bladders could have originated in other than purely aquatic surroundings.

Leaf Bladders.

The remarkable plasticity of these plants has given rise to much speculation with regard to their morphology, and the view has even been expressed that the whole plant is morphologically only a modified leaf. On the other hand, though it has been found that leaf, shoot, and bladder may in some circumstances appear to be, as it were, interchangeable, and each to have the power of producing the other, yet there is a greater constancy of form that has been generally admitted. For instance, in *U. minor* the bladders, which are commonly regarded as modified leaves or parts of leaves, do not appear capriciously on any part of the leaf, but follow a very definite rule. In fact, it is possible to indicate with some approach to precision the actual portions of the leaf which have the capacity to produce bladders. Where there is only one bladder it is always found in a certain position on the leaf, and the positions of the second, third, and subsequent bladders are, if not constant, at least nearly so. Further, it can be shown that they do not by any means always replace leaf segments which would be the case if they were derived by modification of parts of the leaf. The leaf of *U. minor* (and also of the other two species) is primitively bipartite, the third branch which is usually present being really an accessory appendage of one of the two main branches, and springing in successive leaves alternately on the right and the left sides. This accessory branch *never* bears bladders. It appears,

therefore, that the capacity to produce bladders is definitely localized in the leaf. The same is the case in *U. intermedia*, for the bladders which are frequently present always occupy the same position of the leaf.

Trap Mechanism.

The capture of aquatic animals by the bladders is a phenomenon which has attracted much attention, but the method of capture is still a question of some doubt. The mouth of the bladder is closed by a valve, the free edge of which fits so closely against a thickened rim that the opening is water-tight and some force is needed to dislodge the valve and effect an entry. Yet these bladders are constantly found containing numbers of individuals of Entomostraca or larger animals. Before they have captured any prey the bladders are generally rather flattened, with concave walls, and it has been found by Withycombe* that there is a negative pressure within the bladder. The valves bear hairs which project outwards and are said to be sensory—I have myself called them the "trigger hairs"—and Withycombe states that when these hairs are stimulated the edge of the valve lifts slightly, allowing an inrush of water which carries with it the animal which had touched the hairs. Probably the glandular cells upon the valve secrete a substance which is attractive to Entomostraca, and leads them to brush against the trigger hairs. After the inrush of water the valve springs back and closes the entrance, and the "quadrifid glands," which line the inner wall of the bladder, absorb the contained water and the products of the decay of the prey, until the condition of unstable equilibrium is again set up.

The quadrifid glands themselves are of some interest as they vary in form with the species, those of *U. vulgaris*, *U. minor* and *U. intermedia* being quite distinct the one from the other. On the other hand, those of *U. minor* and *U. bremii* are identical, and probably the same is the case with *U. intermedia* and *U. ochroleuca*—a further reason for supposing that the three pairs of forms have a more intimate relation to one another than that of true species.

THE astronomers have been forming a new theory concerning the luminosity of the stars. It was once held that the oceans were formed during the formation of the earth's crust. Later on there was a theory which placed their advent at a time when the earth was comparatively old. The new theory finds a mean. They were formed when the earth was a few thousand years old.

* Journ. Linn. Soc. Botany, XLVI, 1924, p. 401.

† Trans. Norfolk and Norwich Nat. Soc., XI, 1921, p. 151.

Sub-Tropical Meteorology in the Transvaal.

By H. A. Spencer, M.R.C.S. (Eng.), L.R.C.P. (Lond.).

(Life Member S. African Association for the Advancement of Science ; Late District Surgeon, Transvaal).

The meteorological displays in the sub-tropics, as in the tropics, are characterised by the suddenness of their onset and their intensity whilst they last, by whirlwinds or wind-devils, land waterspouts, thunderstorms, dry storms, lightning and sand storms.

AN appointment in the Transvaal which entailed much travelling about, over very long distances and in all conditions of weather, provided me during some twenty-four years with many extraordinary experiences of the meteorological conditions prevailing in the sub-tropics over the inland plateaux and adjacent country.

The daily recording of the usual meteorological observations, by which a Central Department follows the movements of cyclonic disturbances and anti-cyclonic areas over a country of these dimensions, having been added to my medical duties, increased my interest in these climatic manifestations, the long journeys providing opportunity not only of witnessing but far too often of participating in them, providing also much time to ponder over and elucidate what one observed.

The altitude of my very large district varied considerably ; the village I lived in stood on the slopes of a plateau about 5,000 feet above sea-level with not too warm summers—a shade maximum temp. of 94° Fahr. in midsummer was considered very hot—but very cold winters, though no snow had ever been known to fall there in the memory of man. During the four winter months—May to August—it was quite usual to record from 12° to 22° of frost, to see all exposed water coated with thick ice in the morning, water pipes burst and a house side a mass of ice and icicles ! But by ten o'clock in the morning all this had vanished and the sun shone bright and warm in a cloudless sky.

Summer Storms.

Thirty miles away brought one up to an altitude of over 6,000 feet, where snow fell every winter, and the little village looked like one in England, whilst about the same distance in another direction one came to the Low Country or Lowveld, with an altitude of from 3,000 feet to 4,000 feet, where two or three degrees of frost during the winter months would be a maximum. These variations in climate were, of course, due to altitude and to the shelter afforded by the mountains bordering the low country everywhere. And let me explain that "veld" is the South African

name for the surface of the ground, used in the same sense as "prairie" or the smaller application of "field" for which it is the Dutch word.

The climate, however, was an inland one everywhere, for several hundred miles separated my district from the seaboard on every side.

Characteristic of the meteorological conditions existing over the Transvaal is the suddenness of the onset of them and their intensity whilst they last ; during all the summer months—October to February—one might leave one's home in the morning in the most perfect weather, under the bluest and clearest of skies, yet be overtaken on the journey by most violent thunderstorms with vivid lightning and crashing thunder, by sudden flashes of lightning without any rain—exceedingly dangerous to stock, and to those travelling upon the roads—or by most violent hail storms, with hailstones larger than a pigeon's egg, driven perhaps before a strong wind, which so batter the horses or mules that they will often lie down in the cart rather than try to travel against it.

Dry Winters.

In the winter months one may travel without these dangers, but as the four months of winter are dry, no rain falling during this time, the roads and the veld break up into sand and dust, making cart travelling exceedingly trying. It is at this time that the whirlwinds appear, and at the end of the winter and beginning of spring they become most troublesome. It is then no uncommon sight to see a cart or waggon travelling the road ahead of one suddenly disappear in a cloud of dust which may turn it right over, a column of swirling sand, which had sprung up without the slightest warning beside, before or behind the vehicle, roaring and swirling away on its course.

Strange as it may appear it is nevertheless a fact that with the advent of the motor-car in 1912 nearly all these "accidents" on the road, due to meteorological conditions, fell away—were discarded with the cart and horses ! There were no longer horses or mules to be struck by lightning or to be flogged by hail,

the steel casing of the motor meeting these conditions satisfactorily, and when the road one travelled became, during a sudden thunderstorm, a rushing torrent of water a couple of feet deep or more, it was generally possible to feel one's way along and still make progress; occasionally, however, the water gained access through the radiator or the bonnet to the engine and electrical apparatus and stopped the car. Only once in fifteen years have I known a motor-car struck by lightning; then it splashed off a veranda on to the front of the car in a public street during a thunderstorm; on that occasion the driver of the car holding the wheel, though temporarily nearly blinded by the flash, felt no shock of electricity whatever and had to stop and examine the hood and front of the car before he was certain that it had been actually struck. It is my experience also that the greater speed of the motor-car enables one to avoid many localized thunderstorms and hailstorms, even wind-devils are generally escaped in most marvellous manner by the fraction of a second sometimes! A roar in the otherwise still air, close behind the car, would on such an occasion warn one of the proximity of a wind-devil when, glancing back, the dust raised by the car would be seen caught up into a swirling pillar rushing heavenwards and swirling away down the road or on to the veld beside it.

Wind-Devils. Land Waterspouts.

The advent of the motor-car amongst the native towns and villages was hailed with such joy and excitement as I doubt has been produced by any other invention of the white man; he had domesticated all animals and pressed them into service; now he had put a steam engine into a box and made it rush him about all over the world! What to say of his "whitebird that dropped hot eggs as it flew" he did not know, but they heard of its use in East and West Africa to assist in the fighting there. It struck terror into them. What next? they wondered. When a motor appeared upon the road, therefore, they left their towns and villages to a man, shouting "motorcardie" and crowding round it unafraid, laughed and patted it with their hands, inventing uses of the various parts to each other, until a touch of the electric horn made it "speak" and warned them against undue familiarity, when they would rush away laughing and tumbling over each other, assuring themselves the while that they were *not* afraid.

During the windless, still, hot days of early spring, before the rains have set in and when the veld is dried up with the four or even five months of rainless winter, wind-devils may be seen in numbers along the roads or travelling over the veld where it is most

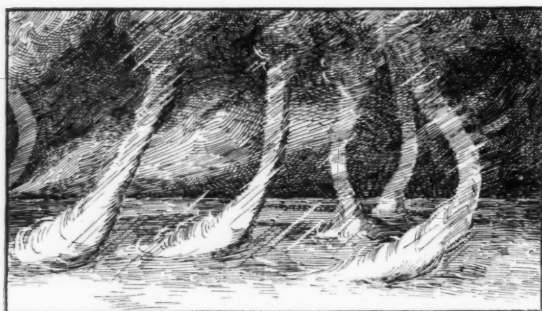
bare. They are columns of sand whirling high up into the air and gyrating across the country at great speed, gathering up as they go leaves, grass, twigs of bushes, pieces of paper, anything detachable in their course; they last for a few moments or for several minutes, but they arise perhaps under the horse's very nose, all in a moment without the slightest warning! With a rush, a roar, and the instant violence of a tornado they are upon you, enveloping you and your vehicle in a cloud of sand, stinging and lashing exposed parts with grit and twigs, blinding the horses and yourself, whilst they perhaps whip off the hood of the cart or car and carry it into the air; you will be fortunate if they do not turn over the cart too, ere a sudden stillness and peace tells you that they have passed on! They are far more interesting to watch as they race ahead or gyrate over the veld, sometimes six or eight of them in sight at once; and be sure that every endeavour is always made to avoid them when possible.

The analogue of the waterspout—sand being substituted for water—the wind-devil starts from the ground below where the great heat has produced a marked rarefaction of the air; instantly there is a violent inrush of the cooler air near by, in an attempt to stabilise, carrying in its rush everything movable with it. A whole newspaper is thus sometimes snatched from a window of a house and swirled high into the air—but the neutralisation of the partial vacuum completed, a cloud of dust floats in the air where the column had been a moment before, paper, leaves, grass and twigs floating quietly back to earth.

Land Waterspouts.

It strikes one as very extraordinary, very out of place, to see numbers of regularly constituted waterspouts stretching from the ground below to the lowering clouds above, rushing and gyrating along over the surface of the land, just as one has seen them at sea; but such may often be witnessed in the Transvaal during the heavy, continuous rains of summer when accompanied by strong, choppy winds—squalls which appear to blow from several directions at the same time. They form quite independently of any collections of water which may be lying in deep depressions upon the veld, known as pans and vleis (ponds and lakes), and of any rivers or streams, from which they are usually seen miles distant upon the higher, exposed plateaux.

As the lowering clouds are blown rapidly along, tongues of whirling rain-water may be seen dropping and hanging from them lower and lower towards the ground until suddenly a swirl of muddy water with grass, leaves, twigs, etc., rushes up from below to join



WIND-DEVILS.

the hanging tongue above and together forming a column continues to swirl and gyrate as a waterspout for some distance over the surface of the ground. Again and again the muddy water from below becomes detached by striking against larger bushes and is at once dissipated, but the tongue from the cloud, travelling on, soon picks up another muddy swirl of water and debris from the ground and continues its course. Many of these land waterspouts may be seen at the same time racing over the veld breaking and reforming so long as the rain and the wind continue.

Land waterspouts are hardly the stately, awe-inspiring waterspouts seen out upon the ocean where, with abundant rain above and practically unlimited sea below, they reach terrifying dimensions in girth and height; but these land analogues are unmistakable as waterspouts and appear to behave and be constituted in the same way under identical conditions of wind currents and driving rain.

Thunderstorms.

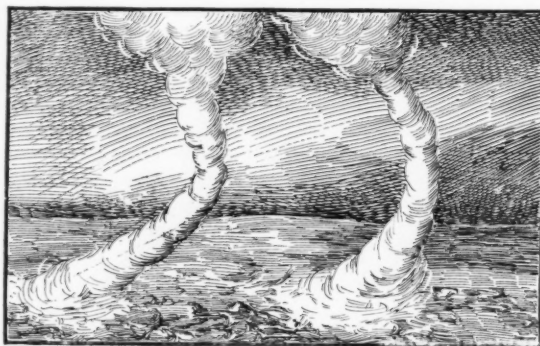
As has already been said, the time for thunderstorms is during the summer months when, after perhaps many weeks of threatening rain, the deluge at last falls and continues to fall more or less regularly thereafter.

Often caught upon the country roads, many miles from home, there is no shelter to be had there against these storms; trees are very few and very far between, lost in the immensity of the country and for such purposes are non-existent. The roads are practically flush with the surface of the country and offer no banks, no cuttings under which to shelter; hedges

belong to older countries, as do walls, not to South Africa! Under these conditions a dark cloud is seen across the far horizon and all speed is made for some homestead alongside the road, but in an hour or less blue sky and sun are blotted out and a wall of water is seen descending from the heavens and approaching rapidly. Soon the noise of great drops hissing through the air and pounding upon hard ground can be heard between the crashes of thunder every few minutes, rapidly increasing in intensity as the storm comes nearer; at last a few great drops of rain fall upon the hood of the car and within two minutes the storm falls upon you!

Rain is now streaming down all round one, not in disconnected drops but in continuous streams of water straight from the heavens; almost at once the road one is travelling on is lost in a rushing, turbulent torrent extending on to the surrounding veld on each side, many yards wide and so deep that it is only possible to force the car very slowly along to some spot where an elevation of the surface lifts it more or less above the water; there one waits the subsidence of the storm before proceeding. It may last only fifteen or twenty minutes and it may be followed immediately by another, but when it

has passed, and blue sky and sun once more appear, one has still to reckon with the small streams and runnels crossing the road which will be rushing torrents now for hours to come, and which are sometimes found from 60 to 100 yards across, deep enough to cover an ox waggon!



WHIRLWINDS.



LAND WATERSPOUTS.

Nearly all the house roofs are still made of galvanized iron in these little Transvaal villages, and when these storms occur the noise they make is deafening; it is impossible to carry on conversation, and the domestic cat and dog are so confused and frightened that they crawl under sofas and into dark places, crouching there until it is all over.

The crashing of the thunder is terrific and shakes the ground, whilst the lightning is very vivid, though, owing to the wall of water around one, it is only seen as a vivid flash of light, and no streaks are seen striking from cloud to ground as when without the storm.

Electric Storms, Dry Storms, Lightning.

It is rarely, however, that damage is done by the lightning during these heavy storms, the pouring rain safely conducting it without delay and distributing it over the wet ground and running water without mischief.

A storm such as described often yields two inches of rain in the rain gauge in less than an hour, and has yielded in that time as much as four inches in my experience.

Thunderstorms are very inconvenient and often alarming in their intensity, but the storm feared more than any other meteorological condition throughout the length and breadth of the land is the electric or "dry storm," when lightning from overcharged clouds strikes to earth without the conducting medium of falling rain. When these storms threaten country people close doors and windows and remain in their houses until the clouds have passed over, for many scores of terrible injuries and sudden deaths are annually caused by these electric discharges, uncondensed and "pushed" from an overcharged cloud, so to speak, striking through their open doors and windows, even down chimneys.

These dry storms occur at the end of the long, dry winter; the night frosts have ceased, the days are becoming progressively warmer, fruit trees blossom and spring has come, but the advent of the rains is still delayed. Then at last clouds appear low down upon the horizon, and day by day come nearer until one day the zenith is overcast with heavy, lowering thunder clouds; this is the time when those who know about these storms shut themselves up against the menace of the terrible electric discharges which may break loose at any moment, with a terrific clap of thunder, and penetrate any window left open.

People are walking the street when, with a blinding flash and a crash of thunder which shakes the earth, a man is struck dead in his tracks. A man and his

wife were lying upon a lowly bed through the heat of the early afternoon, in a daub and wattle cottage upon the veld, the wife nearest a very small window 12 by 14 inches without glass, when a flash of lightning struck through it, across her body, killing her man beside her, but only burning her arm which lay nearest him. As I rode along the road near the village, hurriedly seeking shelter from a threatening storm of this nature, a flash of lightning struck the thatched roof of a native hut beside the road close by, bursting a large hole in it, setting it alight and killing a woman standing beneath with a baby at the breast; the woman had a very perfect cross burnt black upon the front of her body, the track of the electric fluid from her scalp to the floor. Many more such examples might be quoted from my experiences at this season, but the conditions occurring are identical in all—the clouds of a threatening thunderstorm appear to be passing away when one, two, or perhaps three flashes of lightning of dreadful intensity, force and vividness come to earth with terrific crashes of thunder, and the clouds pass away without rain falling. A few days of beautiful weather follow and another dry storm comes over, these conditions being repeated again and again until at last rain falls and the most dangerous season of all the year has passed.

On one occasion far away from home upon a country road, returning from a very long journey late in the afternoon, the darkness, accentuated by an impending storm, was suddenly illuminated by a single flash of most vivid lightning accompanied by a terrific crash of thunder which seemed to shake the firmament and the earth. In the distance stood a bell tent in which seven men who had been working upon the railway near by were crowded, praying upon their knees for delivery from the dreadful menace they knew threatened them; the flash struck the point of this tent, bursting a large hole through it and, splashing off a bicycle lashed to the pole high up, so scattered the electric fluid amongst the occupants that almost all were most severely burnt over the face and the eyes. Three were killed outright, another died before morning, and two others later on, the only survivor being blinded for life. Small wonder that this season and the conditions then prevailing are so well known and so heartily feared by those living exposed in isolated little huts and houses in the district.

Sand Storms.

Occasionally at the time of year at which the dry storms occur a sand or dust storm is experienced, and takes the place of an expected thunderstorm.

Dry storms have come and gone every few days yet no rain has fallen, and during the early afternoon clouds appear to be banking up for the usual storm: perhaps rain *will* come this time! Then, during the course of an hour, the light fades and dark purple clouds cover the zenith, the air is hot and still with a sense of something impending, probably due to the atmosphere being highly charged with electricity. Extraordinarily dark, black or purplish clouds appear overhead hustling about in every direction and may be seen to be flashing lightning one to another accompanied by distant and continuous thunder. Suddenly a strong draught of wind sweeps across the surface of the country; others behind it begin to blow up the dust and in a few minutes a strong wind is roaring and momentarily increasing in intensity as it gathers up dust and grit, snatches the twigs and leaves from trees, the grass from the ground, whirling all high in the air with the force of a hurricane. The eye of the wind is now a wall of brown dust stretching high into the air and forming an extraordinary contrast against the deep purple firmament. Bearing down upon you as you hurry for shelter, the wall of sand engulfs you, blots out all around you; the roaring and

whistling of the wind against houses and through trees is confusing and awe-inspiring. Smitten with grit, leaves and twigs, it is impossible to keep one's eyes open, scarcely possible to make headway on foot against the force of the blast and, hastening into the nearest house, one looks out upon a raging world of blurred confusion and dust in which bushes are whipped this way and that, great trees bowed, bent nearly double and twisted until it seems as though they must snap as they flog the elements with their branches. Sometimes the atmosphere thickens with sand and the outline of surrounding objects is lost; then it clears again slightly and one sees the trees still standing, still flogging. The sand appears to be inexhaustible, though the storm has only been raging for a quarter of an hour, then come intervals when the wind is less violent and the atmosphere a little clearer, the intervals become more and more prolonged, and in an hour or so the wind has dropped, the roads and streets are swept perfectly clear of dust and sand, the atmosphere is bright and invigorating, the sand storm or line squall has passed on. The next and succeeding days will be bright and cool, for the atmosphere has been thoroughly purged; but no rain has *yet* fallen!

Books Received.

- Pegasus*. By COLONEL J. F. C. FULLER. (Kegan Paul. 2s. 6d. net).
- Organic Chemistry*. By JOHN WADE, D.Sc. (George Allen & Unwin Ltd. 8s. 6d. net).
- The Basis of Modern Atomic Theory*. By C. H. DOUGLAS CLARK, B.Sc., D.I.C. (Methuen & Co. 8s. 6d. net).
- An Introduction to Industrial Chemistry*. By S. I. LEVY, M.A., M.D., F.I.C. (G. Bell & Sons. 15s. net).
- The Families of Flowering Plants. Vol. I: "Dicotyledons."* By J. HUTCHINSON, F.L.S. (Macmillan & Co. 20s.).
- Marvels of Sound, Light and Electricity*. By PERCIVAL G. BULL, M.A. (Oxon). (George Routledge & Sons. 6s. net).
- Pleasure and Pain*. By PAUL BOUSFIELD, M.R.C.S. (Eng.), L.R.C.P. (Lond.). (Kegan Paul. 4s. 6d. net).
- War Weather Vignettes*. By ALEXANDER McADIE. (Macmillan & Co. 6s. 6d. net).
- Personality*. By R. G. GORDON, M.D., B.Sc., M.R.C.P., Ed. (Kegan Paul. 10s. 6d. net).
- A Laboratory Guide for a Course in General Botany*. By LEE BONAR, RICHARD M. HOLMAN and LUCILE ROUSH. (Chapman & Hall Ltd. 6s. net).
- Vectorial Mechanics*. By L. SILBERSTEIN, Ph.D. Second edition. (Macmillan & Co. 10s. net).
- A Commercial and Historical Atlas of the World's Airways*. Foreword by SIR W. SEFTON BRANCKER. (Francis J. Field Ltd. 2s. 6d. net).
- Atomcity and Quanta*. By J. H. JEANS, D.Sc., LL.D., F.R.S. (Cambridge University Press. 2s. 6d. net).
- Roving through Southern China*. By HARRY A. FRANCK. (T. Fisher Unwin Ltd. 21s. net).
- My Crowded Solitude*. By JACK McLAREN. (T. Fisher Unwin Ltd. 12s. 6d. net).
- Surgery a Hundred Years Ago*. By PROFESSOR C. B. TILANUS. Translated from the Dutch by JOSEPH BLES. (Geoffrey Bles. 6s. net).
- Cassandra, or the Future of the British Empire*. By F. C. S. SCHILLER. (Kegan Paul. 2s. 6d. net).
- A Dictionary of European Literature*. By LAURIE MAGNUS (Routledge & Sons. 25s. net).
- General Chemistry*. By HORACE G. DEEMING, Professor of Chemistry. (Chapman & Hall Ltd. 17s. 6d. net).
- Laboratory Directions in General Zoology*. By WINTERTON C. CURTIS and MARY J. GUTHRIE. (Chapman & Hall Ltd. 7s. 6d. net).
- Practical Hints to Scientific Travellers*. Edited by H. A. BRONWER. Four volumes. (Martinus Nijhoff. 8s. 6d. per volume).
- The Doldrums of the Atlantic*. By C. S. DURST, B.A. (H.M. Stationery Office. 1s. 6d. net).
- Prehistoric and Roman Wales*. By R. E. M. WHEELER, D.Litt., F.S.A. (Oxford University Press. 18s. net).
- Arabian Medicine and its Influence on the Middle Ages*. By DR. DONALD CAMPBELL. Vols. I and II. (Kegan Paul. 21s. net).
- Practical Physiological Chemistry*. By S. W. COLE, M.A. (Heffers. 16s. net).
- Musical Taste and how to form it*. By M. D. CALVOCOVINI. (Oxford University Press. 2s. 6d.).
- The Appreciation of Music by means of the Pianola and Duo-Art*. By PERCY A. SCHOLES. (Oxford University Press. 5s.).
- Helmholtz's Treatise on Physiological Optics*. Translated from the Third German edition. Edited by JAMES SOUTHALL. Vol. III: "The Perceptions of Vision." (The Optical Society of America. \$7).
- The Journal of the Science Association, Maharajah's College, Vizianagaram*. Vol. II, 1925. Nos. 2 and 3. (Methodist Publishing House, Madras. Annual subscription, Rs. 4 or 8sh.).
- A Naturalist in East Africa*. By G. D. HALE CARPENTER, D.M. (Oxon), M.B.E. (Oxford University Press. 15s. net).
- Pyrometers*. By EZER GRIFFITHS, D.Sc. (Sir Isaac Pitman & Sons. 7s. 6d. net).
- Adventures by Sea from Art of Old Time*. By BASIL LUBBOCK. Preface by JOHN MASEFIELD. (The Studio Ltd. 3 guineas net).

The Sense of Smell.

By Dr. Eric Ponder.

All our knowledge is limited by the five senses. Of these the sense of smell is the most mysterious. There are several theories about smell, but nothing really satisfactory and convincing in the way of an explanation. Terror of cats and belief in haunted houses may be explained by a subconscious sense of smell.

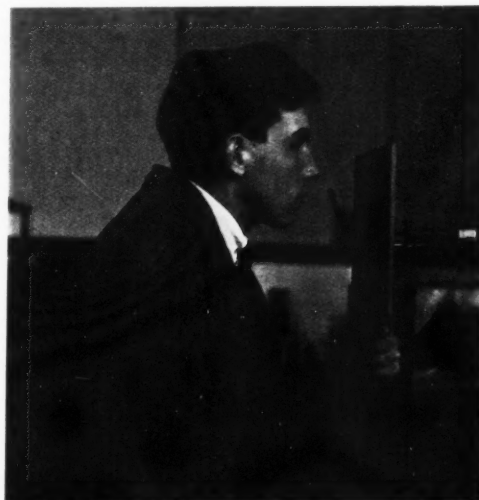
CONSIDERING how important they are to us, our five senses have received at the hands of present-day science rather less than their proper share of attention. We know a good deal about the sense of sight, because it is indispensable to us; about the sense of hearing we know less, and when we come to the most primitive of the special senses, that of smell, we know practically nothing at all. Whatever other reasons there may be for this, one is that smell plays a comparatively small part in our modern life; it is a much neglected sense, usually dismissed as being vestigial or undeveloped and scarcely worthy of serious attention. Sensations of smell are perceived by an organ of extreme simplicity, and yet by one which has extraordinary powers of discrimination; unnoticed though they be, they of all sensations have the greatest effect on our thoughts and emotions. Indeed, the sense of smell, instead of being the last, might well be considered the first of the five, whether we give it this place because of its importance, its primitiveness, or its mystery. It is more nearly connected with our inner emotional life than are the more practically useful senses of sight and hearing and, at the same time, a study of it presents more interesting points than most people realize.

Smelling Hairs.

Sensations of smell, unless you like to count those of touch, are the most elementary sensations we know, occurring as they do throughout the whole scale of animal creation, even in creatures so lowly as the sea-anemone. As one might expect, the organ which receives these sensations is in itself simple, consisting

of myriads of tiny units—the olfactory cells—whose appearance is invariable throughout the entire animal kingdom. Each little cell is a rod-shaped body ending in an enlargement on which is a cluster of fine hairs; at the other end of the cell is a nerve fibre which, joining with others, forms the olfactory nerve or nerve of smell proceeding to the brain. In man these little cells are restricted to a small area—about a square inch in size—situated in the deeply-seated

parts of the nose, the little hairs of the cells projecting into the current of air which is always passing up and down as we breathe. In some animals, such as the dog, the cells occupy a larger area in the nose, while in others, such as the whales and seals, the area is much smaller; indeed, the development of the olfactory organ appears to go hand-in-hand with the animal's requirements, the dog and the four-footed tribe obviously needing the sense of smell more than do the seals and whales. In insects, the olfactory cells lie in little culs-de-sac in the antennae and mouth parts, while in the sea-anemone they are found on the surface of the skin; wherever they are situated their structure is much the same—just rod-shaped cells with hairs at one end. And wherever they are found there is to be seen lying among them certain pigment cells—cells of great importance, as we shall see.



ONE TYPE OF INSTRUMENT FOR MEASURING THE ACUTENESS OF OLFACTORY SENSATIONS. The odorous substance is put on a porcelain tube, and brought nearer the percipient until he perceives it.

Smell Testing.

Compared with the ear or the eye, the structure of the olfactory organ is therefore one of great simplicity. "Yes," you will say, "but look how much simpler its function is. The nose has only to deal with smells, much simpler things than colours or sounds."—In

which remark you are mistaken. The sense of smell possesses an unrivalled power of discrimination, for we can, by this simple organ, detect the most minute quantities of odorous substances in the air we breathe.

The special instrument used for finding the sensitivity of the olfactory cells to various odours is called an olfactometer, there being many different forms. One of the most commonly used consists of a porous tube which slides over a fixed metal tube; according to the position of the porous tube, which is impregnated with the odorous substance, a greater or a less quantity of that substance is carried to the nostrils. If the tube is saturated with vanillin, we find that the average person can recognize as little as one thousand-millionth of a gramme. Nor is this the limit, for other substances are recognized in even smaller quantity. This extraordinary power of perception is well enough known to everybody, for we all know that we can detect impurity in the air of a room by the smell, although chemical tests are quite unable to show the presence of impurities. But the sense of smell is not characterized by its power of perception alone; it has just as remarkable a power of discrimination. The variety of odours is unlimited—there are all the natural odours, the odours of the plant world and of animals, perfumes belonging to minerals and inorganic material, and the innumerable perfumes of substances synthesized by chemists. Each one the sense of smell can recognize as different; its powers of discrimination are practically unlimited.

Literary Difficulties.

Although we can recognize and distinguish an enormous number of odours, we can, however, name very few. There used to be a popular parlour game which consisted of smelling a number of unlabelled bottles, each of which contained a substance with a smell, and then naming each substance by its odour. This is a very difficult thing to do, for although we can generally distinguish between the odours of two substances, even if they are very similar, it is often impossible to name the substances to which the odours belong. The difficulty arises principally from the vagueness with which we speak of smells. While we refer to colours in a definite way, and while we can describe a sound as minutely as we like by giving its pitch and quality, we cannot speak of "the mouldy smell" or "the stuffy smell" with the same precision as we can speak of the colour violet or of the sound called a whistle. The sense of smell is devoid of description; it has no language, and from this point of view is indeed undeveloped. The best we can do is to divide odours into etherial, aromatic, garlicky,

disgusting, and nauseating smells—all vague terms, for into each group there fall thousands of different odours, each of which is easily distinguished by us.

The simple organ of smell thus appears to have anything but a simple function. We can to some extent understand how the ear and the eye perform their duties, for we are helped by their complex appearance, but what can one make of the olfactory organ—a mass of cells with hairs, and a few pigment cells? What key does the structure give us? Very little; it is all too simple, and thus mysterious. Many theories have been put forward, some likely, some impossible, to explain how these cells function; no single one can be accepted without reservation, but it may interest the reader to be told the little we know.

Chemical or Physical?

Anything we smell must be in a gaseous state, for it has to be carried to the nostrils in the air which we breathe. It may be in the inspired air, as when we smell a perfume, or in the expired air passing from the region of the mouth and throat into the nose, as are the substances which are responsible for the flavour of food and drink, for flavour is not perceived by the sense of taste, but by the sense of smell, as anyone who has had his nose blocked up by a cold will realize. The odorous substance is thus brought into contact with the hairs of the olfactory cells, which are apparently stimulated, and a sensation of smell results. This is agreed, but how does the stimulation occur? Is it chemical, the odorous substance affecting the hairs like a chemical reagent, or is it physical, depending on waves in the air or ether, as in the case of the senses of hearing or sight? Here admitted fact ends, and speculation begins; some people claim that the effect is chemical, and others that it is physical.

We seek in vain for any relation between chemical constitution and smell; although certain substances which are called "aromatics" have both the same odour and a similar chemical constitution, and although certain compounds of arsenic and phosphorus smell of garlic, any relation between chemical composition and odour breaks down completely as we examine it more closely. Artificial and natural musk, for instance, have the same odour, but are chemically utterly different; prussic acid and nitrobenzol smell the same, but are totally unlike in structure. Many other examples could be given of the failure of this suggestion, and we have therefore to seek explanations on other lines.

Impressed by this failure, physiologists have been

led to suggest that the action of odorous substances may be not chemical but physical. The minute particles of which the substances are made up—particles called molecules—are known to be in a state of very rapid vibration, and it is supposed that these rapid movements set up in the surrounding air little waves, just as the movement of a stone sets up ripples on a pond. These tiny waves are then propagated through the air in the nose, and fall on the hairs of the olfactory cells, which are caused to rock to and fro thereby; the movements of the hairs thus set up an impulse in the cell to which they are attached, the impulse is carried to the brain, and there interpreted as a smell. In this way the vibrating molecules act somewhat like a wireless transmitter, and the hairs of the cells like a detector, the principal difference being that the waves, instead of being metres in length, are exceedingly short—shorter, indeed, than the waves of light. Since a molecule of camphor vibrates at a different rate from a molecule of, say, turpentine, each sets up its own particular length of wave; the hairs of the olfactory cells are stimulated in the one case by a wave of a particular length, and in the other by one which is perhaps shorter; in this way it comes about that camphor is recognized as smelling different from turpentine, and in the same way we can have as many different kinds of smell recognized as there are lengths of wave which can be generated and received.

To this theory, too, there are some serious objections, for, if there were not, the sense of smell would not be the mystery it is. According to the theory, prussic acid should smell the same as steam, for the waves generated are identical; of course, they do not smell the same, for one is odourless while the other smells powerfully of almonds. Thus we have still the unsolved problem; the chemical explanation fails us, and the physical explanation fails us too—neither accounts for the facts, and the sense of smell guards its secrets. It may be, of course, that both theories are true in part, or that the exceptions are only apparent exceptions which would disappear if we knew the facts more fully, but so far we have to admit defeat.

Pigment Cells.

Nor does the problem end with the olfactory cells which, because they terminate in nerves, we take to be the principal receiving elements, for it seems that the pigment cells which surround them also play their part in the perception of odours. In some animals whose sense of smell is very acute, such as the dog and the deer, these pigment cells are very pro-

minent, and richly loaded with their coloured material. On the other hand, in animals with a poor sense of smell, such as seals, there are very few pigment cells, and in albinos, which have no pigment cells at all, we find the sense of smell almost absent. This fact is well known to sheep rearers in certain parts of the world, for they refuse to rear albino sheep, knowing well that they will be unable, because of their poorly-developed sense of smell, to detect poisonous plants, and that sooner or later they will die through eating



DIAGRAM OF TWO OLFACTORY CELLS WITH A PIGMENT CELL BETWEEN.

Note the fine hairs at the ends of the olfactory cells and the nerve endings to the left.

herbs which their better-equipped brethren would avoid. The part played by the pigment cells also explains why dark-skinned races have a better sense of smell than the white races, and also why our sense of smell becomes more acute as we grow older—unlike any other sense—for with advancing age more pigment is laid down among the olfactory cells.

Nose Cultivation.

One is perhaps rather apt to look upon the sense of smell as one which is fixed and unalterable; we know that eyesight fails with age, and that the sense of hearing is subject to very diverse modifications, but so fixed an idea have we of the simplicity of the olfactory sense that we never think that equally interesting observations attach themselves to it. As a matter of fact, recent investigations have shown that there are as many curiosities attached to this sense as to any other. As I have said, it is the only sense which becomes more acute with age. Infants, as soon as they are born, perceive odours, but apparently not strongly; as the child grows up, the sense slowly develops until about the age of fourteen, when a curious difference between the olfaction of the male and the female makes its appearance. After this age, not only has the female a more acute sense of smell than has the male, but each prefers a different kind of odorous substance. Men like such odours as pine-oil, musk, and cedar oil, while women as a rule dislike them. Women, on the other hand, show a preference for scents which men dislike, especially for camphor, menthol, and citronella. Why these differences should exist is not known, but they are very sharply marked. It has been suggested that

they may be based on those factors which are said to determine the more acute sense of smell in females—excessive smoking among men, this tending to dull the sense, and the greater need for olfaction in women, since they engage in cooking and the domestic arts. If this be the reason, the differences will soon disappear with the advance of modern tendencies.

As we grow older the sense of smell becomes not only more acute, but more discriminating. Such tastes as the liking for high game and over-ripe cheese are not natural; they are only acquired as age advances, and are quite foreign to young people. The development as we grow older is also connected with another fact: as we have increasing experience we tend to take more notice of our sensations. From this point of view the sense of smell is eminently adapted to education, for if we pay attention to our perceptions of odours, as a wine-taster or a gourmet does, we can easily cultivate the sense and increase its discriminating powers. This occurs to an extraordinary extent in a few people who have so keen a sense of smell that they can distinguish people by their odour, and even streets by their own peculiar aroma. Whitechapel, I daresay, smells different from Mayfair, and no doubt many could recognize the difference, but how many do? Not very many, for most of us think that we can get on quite well without the sense of olfaction, so far as matters of ordinary life are concerned, and so become accustomed to allow our sensations to pass unnoticed. But because they are unnoticed, we are by no means uninfluenced by them.

Odorous Suggestion.

This is just what constitutes the peculiarity of the sense of smell. We get sensations, as with any other sense, but for some peculiar reason they do not always pass over the threshold into consciousness, and if they do pass, they are frequently unrecognizably altered in the process. Take an example: You may go to a disused house, and as you enter you feel a curious and unexplainable repugnance to the place. The idea cannot be shaken off, and you elaborate it half unconsciously; you say you feel that there is something sinister about the place, and you may even end by believing that it is haunted. All that has really happened, in nine cases out of ten, is that your sense of smell, more alert than you give it credit to be, has informed you that the place smells unventilated and musty. But this sensation does not pass into consciousness as it stands—unless it is a very strong one and the house actually reeks of something—it becomes changed, transposed into something

other than a mere perception of smell, and gives rise to a vague fear and feeling of discomfort. Sensations of smell are almost unique in this respect; relegated to unused attics of our minds, they appear in unrecognized forms through other channels. Many of the unexplained antipathies which certain people possess—as, for instance, the very general dislike of cats and the ability of knowing, by a kind of vague feeling, when one of the detested creatures is in a room—can be explained in a somewhat similar way. It is quite likely that under these circumstances one is warned of the cat's presence by an unnoticed sensation of smell.

Remembering Smells.

Not only is the olfactory sense itself a very subsidiary one for the purposes of everyday life, but the memory of odours is in most people exceedingly defective. Out of every hundred people, only about ten or fifteen can recollect in a realistic way a particular odour; if you ask the average person to call up in his mind the smell of roses, he will probably fail completely. Sometimes by concentrating his mind on a scene which, in his past experience, was associated with roses, he may succeed, but even then the realism of the memory in no way compares with the actual sensation of the fragrance of the flowers. This is, of course, the inevitable result of our paying so little attention to our olfactory sensations. But suppose that we now reverse the process, and give the person roses to smell, preferably when his mind is unoccupied by any particular train of thought; at once, in nine cases out of ten, some past scene rises into his mind, emotions are let loose, and he recalls things long past which he could not have remembered by the greatest effort. Odours are an unfailing key to the subconscious, and arouse more emotions than do any other sensation. This fact has had a very interesting application, for nowadays memory is often stimulated by the use of different odours, at such times as when a person is undergoing psychoanalysis, and the same device for making unwilling folks register emotion has even been introduced into the criminal practice of some of the American courts. It is said to be unfailing. Anyone who doubts the efficacy of the method can try it on himself, placing himself mentally at rest and then inhaling the odours of such substances as scented soap, spices, flowers, and so on: it is extraordinary what long-forgotten scenes and curious emotions come into the mind under such simple stimulation.

The sense of smell is thus one of those little islands untouched by the advance of science, unclaimed for its proper use; we do not know how the olfactory

organ functions, we know little about olfactory memory, we do not know enough about the potentialities of the sense to employ it usefully. There are many such little islands, but there are few on which

the amateur investigator, armed with nothing but his interest and a power of observation, can advance so safely and with such prospects of finding what others have missed in their search.

Soil Bacteria and Nitrogen Fixation.

By P. H. H. Gray, M.A.

(Rothamsted Experimental Station.)

Recent research on nitrogen-fixing bacteria indicates that while little can be done by adding cultures of bacteria to the soil, a great deal can be done by ploughing in a suitable green crop in order to make the soil a naturally favourable medium for the growth of the nitrogen bacteria.

IN cultivated soils three elements constitute an important group, the deficiency of any one of which is a factor limiting the growth of crops. These elements are nitrogen, phosphorus and potassium. The remaining elements essential to plant growth are present and available in soil in sufficient abundance or are obtained from the soil water—hydrogen—or from the air—carbon and oxygen. It is an aim of farming operations to maintain an adequate supply of those elements which are liable to be depleted by continuous cropping. This is the basis of all manurial treatment with organic material such as farmyard manure, and with artificials such as ammonium compounds, phosphate and potash fertilizers.

Nitrogen Sources.

Virgin soils generally contain a sufficient supply of these limiting elements; in the early systems of agriculture an area would be cropped until signs of poor yield became evident, whereupon a move would be made to fresh quarters. Even under modern conditions, as for example in America, this has often been the normal practice. In thickly populated countries such a course is impossible, and the materials indicated are used to keep fertility at a high level. Nitrogen is found in soils in the smallest amount, and is more rapidly used up or lost than either phosphorus or potassium. The main limiting factor, therefore, is nitrogen, sources of which are Chilean nitrate, sulphate of ammonia, organic waste materials such as "shoddy," blood from slaughter-houses, and fish, the excreta of birds and farm animals, and the air.

The deposits of nitrate in Chile were for a long time the main source of the supplies of sodium nitrate used both in agriculture and in the chemical industries. The deposits, enormous as they are, are by no means inexhaustible. The demand for ammonium sulphate from coke ovens and gas-works coal is equally large and, should the Chilean deposits fail, will easily exceed

the supply. As to the animal manures, although about thirty-seven million tons of farmyard manure are estimated to be produced annually in this country, this supply has never been able to satisfy the demand for it and, with the rapid development of horseless traction, is becoming more and more scarce. It is still the most valuable kind of organic manure, in that it produces the essential good physical conditions in the soil as well as supplies the three important elements of plant food.* The other organic substances are available in only a comparatively small percentage.

The last of the above-mentioned sources of nitrogen remains to be considered—the air. Nitrogen is present in the air as gas, 77 per cent by volume. It has been calculated that above one square yard of land there is as much as seven tons of this gas. If the amount covering one acre could be converted into nitrate—the form in which plants mainly absorb it from the soil—the value thereof would be about £20,000,000. There are two ways in which atmospheric nitrogen can be captured and turned to use for the service of man—the one physico-chemical and the other biological.

New Fixing Methods.

The famous warning delivered by Sir William Crookes at the Bristol meeting of the British Association in 1898, to the effect that the supplies of combined nitrogen available for the bread-eating nations would come to an end in 1931, and experiments by Crookes and Lord Rayleigh in the 'nineties, have proved to have been productive of a development in industrial chemistry of the utmost importance to agriculture. This is the fixing of atmospheric nitrogen by means of electricity, and it has been so far found possible to do this in three ways, which depend upon the affinity that nitrogen has for combining with oxygen, hydrogen,

* *Discovery*, February, 1925.

and certain metallic compounds. In the first case nitrous or nitric acid is formed, and is then converted by suitable methods into the salts which can be taken up by plants; with hydrogen ammonia is formed, and the compounds produced undergo certain changes in the soil whereby they are converted into plant food. A typical example resulting from the combination of nitrogen with metallic compounds is calcium cyanamide, the basis of which is calcium carbide. Since the supplies of atmospheric nitrogen are unlimited, the nitrogen famine predicted as being imminent through the using up of the then known supplies is not likely to occur.

It is out of place to discuss here the various methods and their relative efficiency, but it should be borne in mind that an enormous amount of electrical energy, mainly derived from water power, is consumed at the high temperatures, and great pressure is necessary to fix a small amount of nitrogen. Present-day prices of nitrate of soda and ammonium sulphate are at London £12-£13 per ton, though the latest developments of a British fixation plant indicate that a much lower figure is economically possible. The cost of the prepared products is well within the reach of the farmer, but the superiority of animal manures over the artificials will, for the reasons stated, continue to cause agriculturists to search for a cheaper means of enriching their soils.

Turning in Crops.

Turning now to the biological methods of restoring soil fertility, especially by increasing the nitrogen supply, a method called green manuring—that is, the ploughing under of crops grown in the interval between the reaping of one crop and the sowing of the next—is in many parts of the world a normal practice in arable farming. Green plants such as mustard, grown with mineral manures, have been largely used to enrich the soil, for what is taken out by the growing crop is returned with interest when it is ploughed in, the cellulosic material which has been synthesized from the carbon-dioxide of the air serving the additional purpose of creating or maintaining a good tilth. Plants of the order *Leguminosae* are especially valuable for this purpose. Theophrastus, about 2200 years ago, wrote "of the leguminous plants the bean best reinvigorates the ground." Pliny says that "the soil is enriched by the growth of a crop of lupins; indeed, so far is it from standing in need of manure, the lupins will act upon it as well as the very best." The difference due to this type of plant lies in the fact that the amount of nitrogen returned is greater than that taken up from the soil. Vetches, for example,

when turned under at the proper time can add to an acre a clear gain of nitrogen such as would be supplied by ten tons of farmyard manure.

The explanation of this last remarkable fact was given for the first time less than forty years ago, and that is, that leguminous plants have on their roots small swellings called "nodules," and inside these nodules are bacteria that have the power of taking nitrogen from the air; this nitrogen, above their own needs, they pass on to the plant. Thus, by the combined activity of certain higher plants, dependent on sunlight for their growth, and a specialized type of bacteria working in the dark, fertility is increased when this captured (fixed) nitrogen is returned into the soil.

The power of fixing nitrogen is not confined to the bacteria that live in symbiosis with leguminous plants. Certain free-living forms have been discovered that can similarly utilize atmospheric nitrogen in order to build up their protoplasm. This also is a matter of fundamental importance to agriculture, for not only are nitrogen compounds removed by crops that are continually being taken off, but nitrates may

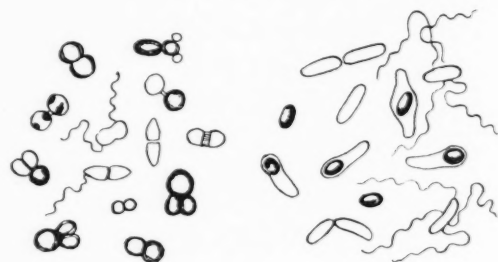


FIG. 1.
A—AZOTOBACTER. B—CLOSTRIDIUM.

be washed out of the soil by heavy rainfall or reduced by some bacteria to elemental nitrogen. Berthelot in 1883 found that in uncropped soil, after the nitric acid in the rainfall had been accounted for, there occurred a gain as high as 45 per cent in the nitrate content. Shortly afterwards Winogradsky discovered a free-living form of bacteria which, in pure culture, could fix atmospheric nitrogen when supplied with the right source of energy. From the spindle shape of its cells and in honour of the founder of modern microbiology the organism was named *Clostridium Pasteurianum*. (Fig. 1). Its activity mainly took place in the absence of free oxygen, but since arable soils are thoroughly aerated by cultivation, Beijerinck's discovery in 1901 of a nitrogen-fixer that works only in the presence of free oxygen appears to have a more important bearing for agriculture. Many

strains of this organism, called *Azotobacter*, have since been described and studies made upon its distribution. The sketch (Fig. 1) shows some of the forms assumed by it in culture and in soil.

Sunlight Energy.

Unlike the higher plants, bacteria are unable to derive the energy needed for their life-processes from sunlight. They depend in the main upon organic compounds which serve the dual purpose of assisting in cell building and in supplying energy. The nitrogen-fixing bacteria differ from other kinds in that they require a much greater supply of easily available food for the energy required to bring into combination the nitrogen of the air. Just as in the physico-chemical methods previously mentioned, for a unit weight of nitrogen fixed a certain amount of energy expenditure is required, so the efficiency of the biological fixation can be estimated by ascertaining the amount of carbon consumed by the organisms when fixing a given amount of nitrogen; in other words, the carbon-nitrogen ratio is an index of efficiency. The efficiency varies with the species; some, the *Clostridium*, for example, do not bring about a complete oxidation of the carbohydrate, but produce substances such as butyric acid. The energy then available for the fixation process is not so large in amount as would be the case had the carbohydrate been oxidized to CO_2 and water. The efficiency of *Azotobacter*, the most important of these bacteria, is high, as much as fifteen to twenty milligrammes of nitrogen being fixed for every gramme of carbohydrate consumed. Since the amount of carbon dioxide produced is large, with very small traces of other acids, a considerable amount of the energy released by such an economical oxidation is rendered available for the nitrogen-fixation process. Young actively growing cultures fix nitrogen much more efficiently than older ones; this is shown in the graph (Fig. 2).

Variation Factors.

This efficiency in the case of *Azotobacter* is much higher in soil. Here the nature of the surrounding conditions greatly influences the process. Thus it has been found that whereas in culture solution the bacteria required as much as two hundred grammes of sugar to assimilate one gramme of nitrogen, in sand, a well-aerated medium, they required as little as thirty grammes to fix the same amount. If, on the other hand, much available nitrogen in the form of nitrate be present the organism will use this in preference to going through the more difficult process of fixation. This is well illustrated in the figures that follow:

Cultures without nitrate

At end

Cultures with nitrate

mgms.

At start

8.55

At end

0.20

Nitrogen fixed

mgms.

3.74

Nitrogen fixed

mgms.

-0.40

Fixation in the soil is depressed in this way for the same reason, but under certain conditions *Azotobacter* can fix nitrogen in the presence of nitrate; for example, by utilizing the by-products of cellulose decomposition by other organisms, which make use of the nitrate in order to break down the cellulose.

Energy-yielding materials that may reach the soil in the course of arable farming are varied; in addition to cellulose these may be sugars, starches, gums, dextrin, and similar carbonaceous compounds such as occur in stubble, roots, leaves, or animal manures, the bulk of which is straw. The effect of adding material of a non-nitrogenous nature to soil has been discussed in a previous article in this Journal. It was stated that depressions in crop yield usually attend the incorporation of cellulosic material into the soil, since the cellulose-destroying bacteria draw upon the available nitrate in order to build up their protoplasm. In soil, cellulose or other carbonaceous material may act favourably for nitrogen-fixation if applied at the right time; thus, applied in the autumn when the land is warm the carbohydrate will be consumed in time to allow of nitrogen gains to accumulate before the spring sowing; such an application would be analogous to the turning in of the residues of the previous cereal crop. The effect of a spring application on the other hand is evident from the following table:

Carbon compound added

Crop obtained

1st year 2nd year
(per cent of control)

Cane sugar, 2 per cent

33 186

" " 4 per cent

38 283

By the second year the bad effect has given place to a good one. The soil, moreover, was left much richer in nitrogen, although a greater amount was removed in the crop than was previously in the soil.

Phosphate Needs.

This may be bound up with the phosphate requirements of *Azotobacter*, an analysis by Stoklasa having shown that about 60 per cent of its ash consists of phosphoric acid. In cultures a considerable amount of phosphate is needed for its full development, and the addition of these salts to soil has the effect, *inter*

alia, of stimulating nitrogen fixation. Indeed, lack of phosphate in soils has been found by Christensen to be a factor limiting the growth of *Azotobacter*. Such soils have only a slight power of breaking down mannitol, a carbon compound much favoured by this organism in the fixation process. Those soils, however, to which superphosphate has been added in normal quantities for many years in accordance with their phosphoric acid requirements can break down mannitol much more vigorously. Thus it may prove possible that the addition of straw or other carbonaceous material, and phosphate, either in spring with a leguminous crop, or in the autumn without, would greatly benefit the soil in two directions, namely, by maintaining a good tilth and by increasing the nitrogen for a succeeding cereal crop.

Symbiosis

A further point of interest lies in the symbiosis of *Azotobacter* with other soil organisms. This aspect of soil microbiology offers an inviting field for future research, for the present evidence points to its being a factor of considerable importance. Thus, although as has already been pointed out, *Azotobacter* is most favoured by conditions under which it can get free oxygen, its operations must be carried on without exposure to sunlight. A symbiosis between this organism and green *Algae* has been described; under these conditions more nitrogen was fixed than when the bacteria were grown alone. Since the fixation of nitrogen by *Algae* has been so far disproven, though carefully tested by Bristol and Page at Rothamsted, the benefit of this symbiosis is clear. Also in association with other bacteria *Azotobacter* will fix more nitrogen than when alone; a greater fixation can also be obtained when two strains of the organism are grown together. The *Clostridium* has been found to be greatly benefited by the presence of the aerobic organism; in this case *Azotobacter* absorbs the surrounding oxygen and so enables the *Clostridium* to work in the absence of air. Such a state of affairs may also obtain when a non-nitrogen fixer is associated with the former species. This has been admirably shown by Richards, who cultivated together *Azotobacter* and an organism which can break down starch into compounds that the former can use. The following figures are taken from his paper:

NITROGEN FIXED, MGMS.

By mixed culture	By <i>Azotobacter</i> alone
4.39	1.49

In considering the natural surroundings of these bacteria, it is a well-marked characteristic of *Azotobacter*

that it is most intolerant of slight traces of acidity. The addition of lime to soils that have become acid is a normal practice in farming; if other conditions are right it has the effect of increasing the nitrogen-fixing power of the soil, and Prof. Christensen, of Denmark, has found a close association between the occurrence of this organism and the lime requirements of the soil; he has indeed designed a method based upon this fact whereby the approximate amount of lime required may be estimated.

The question has arisen whether it may not be possible to increase soil fertility by adding thereto cultures of some of these important bacteria. It is true that in the laboratory the addition of sugar or mannitol to soil can result in the development of a nearly pure culture of *Azotobacter*, the normal flora being almost crowded out; similar results probably

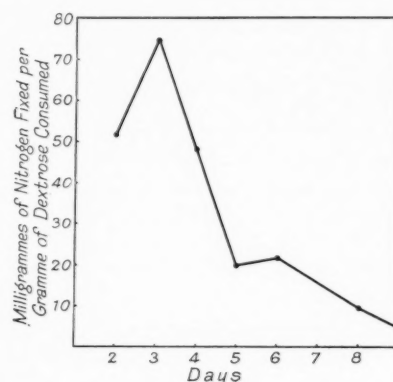


FIG. 2.
NITROGEN FIXATION BY AZOTOBACTER.
Decrease of efficiency with the age of culture.
(Koch and Seydel).

attend such treatment of field soil at certain times of the year. Normally, however, the competition which goes on between the numerous groups of the micro-population is so intense that large accumulations of nitrogen due to the activity of the nitrogen fixers hardly ever occur. The possibility, therefore, of increasing fertility to any extent by inoculating soils with pure cultures of *Azotobacter* is at present impracticable, although attempts have been made in many countries to attain this object with commercial preparations. The addition to the already teeming soil population of a few millions of a pure culture cannot make any difference to the numbers already present, and it seems more probable that the greater benefit will accrue by making the conditions of the environment more suited to the organism.

Book Reviews.

Science, Religion and Reality. Edited by JOSEPH NEEDHAM.
(The Sheldon Press. 12s. 6d.).

This book, and the volume "Evolution in the Light of Modern Knowledge," bring vividly before the mind of the present generation the old problem of science and religion. Each is the work of several hands—writers co-ordinated more or less by their editors. Mr. Needham has a very distinguished team of collaborators. The Earl of Balfour gives in the introduction the gist of his Gifford Lectures of 1914 and 1915. He points out how very different are the spheres of religion and of scientific research, and indicates how terms of peace between them may be made possible. Dr. B. Malinkowski of London contributes a chapter on magic, science and religion, full of the latest views and conclusions of the social anthropologist. It describes the relation between religion and science among primitive races. The history of this relation down to the nineteenth century is given by Dr. C. Singer. The great controversy of the nineteenth century—the ape-or-angel controversy, associated principally with Darwin and Huxley, is described by Professor A. Aliotta of Naples. The domain of physical science, perhaps the best chapter in a book of good chapters, is discussed by Professor A. S. Eddington of Cambridge. He shows that natural laws may be conveniently divided into three kinds: identical, statistical, and transcendental laws. Interference of human free-will with laws of the first kind—of which the law of the conservation of mass is typical—cannot be admitted. "Even omnipotence could scarcely set these aside." There is a possibility, however, that when we make up our minds to do something interference with a law of the two other kinds may be possible, but he is not very optimistic on this. Recent work in science, he believes, shows how much greater an instrument is mind than was formerly recognized.

The editor writes an admirable chapter on mechanistic biology and the religious consciousness. He makes short work of the neo-vitalists and of those who cannot believe that biology is merely applied physics and chemistry. Physics and chemistry, he says, will one day, if not now, describe all the phenomena of bodily life, but the materialistic conclusion is now drawn. The jurisdiction of mechanism over other fields of experience is not admitted; it cannot be applied, for example, to psychology. The editor concludes that there is nothing to prevent a thorough-going mechanist in biology from believing in religion. Chapters on the sphere of religion, on religion and psychology, and on science, Christianity and modern civilization, are contributed by Professor J. Oman, Dr. W. Brown, and Professor Clement Webb respectively. The Dean of St. Paul's sums up and intrudes upon the conclusions his well-known views on organized religion and on progress.

Altogether it is a most stimulating and informative work. Each contributor has done his allotted task well. The work as a whole would have been better had it been possible for the contributors to meet in conference and to rewrite their chapters after a general discussion. It is intended neither as a defence nor a criticism of Christianity; it serves to show that truth is a many-sided thing and not confined to one chosen branch of experience.

A. S. R.

Vectorial Mechanics. By L. SILBERSTEIN, Ph.D. (Macmillan & Co. 10s.).

The second edition of this textbook bears witness to its comprehensiveness. It has only been found necessary to add

a few notes. The growing use of vectorial methods in calculation of all kinds is noteworthy, and this approach through mechanics is a convenient method of interesting workers unfamiliar with the system.

The Mummy. By SIR E. A. WALLIS BUDGE, Kt., M.A., Litt.D., F.S.A., etc. (Cambridge University Press. 45s. net).

Egyptology is an enthralling subject, but it has suffered in the past from the rather forbidding nature of its literature. The average man has wanted a readily accessible, readable, and authoritative guide to the subject. This, the second edition, greatly enlarged and revised, is still called "The Mummy; a Handbook of Egyptian Funerary Archaeology," but it is far more than that. It is the history of the archaeological research which has given us a history of Egypt. In his preface the author says: "During my years of service in the British Museum I kept a list of all the reasonable questions put to me by members of the public, who were seeking information about Egyptian 'antiques' either as collectors or as students of Egyptology." This perhaps gives us a clue to the astonishingly live interest that informs every chapter of the book. It answers these endless questions we ignorant but interested laymen ask. Here is a book which will lead the student and inform the learned.

The first part deals with the confused subject of Egyptian chronology, the outline of the history of Egypt, and the solution of the hieroglyphics by the deciphering of the Rosetta stone. Full credit is given to Young, who has a greater claim to be regarded as the true solver of the problem than Champollion.

The sixteenth-century use of pounded mummy as a drug is a reminder of the gruesome symbolic pharmacopœia of those days. There were plenty of mummies in Egypt, but even so it was cheaper to make bogus mummy for export. A Damietta Jew so ill-treated his Christian slave that the latter gave away the tricks of the trade to the Pasha. It was found that the Jews bought the bodies of those who had died from loathsome diseases, stuffed them with bitumen and dried them in the sun so that they looked like old mummies! But for this fortunate discovery which put an end to the export trade modern Egyptologists might be short of material.

Every detail of the funeral furniture and mummy case is discussed, and the book is plentifully illustrated with photographs of exhibits now in the British Museum, including a bronze cast of the portrait statue of Tutankhamen. It adds no little to the interest and value of the book that the reader has access to this wealth of material and can see the actual things themselves by simply visiting the British Museum. In the same way the thousands who have visited the Egyptian galleries, and have only partly understood the things they have seen, will find this book tells them the whole story of ancient Egypt that the labour of moderns like the author has revealed to the world.

The original edition of 1893 went out of print in six months or so. This is to all intents and purposes a new book, and has all the fresh knowledge of thirty years of specialized work added to it. We hope that the publishers have prepared against this occurring again, for it is the long-awaited standard work on Egyptology which everyone interested in the subject has hoped would be made available.

Surgery a Hundred Years Ago. Translated from the Dutch by JOSEPH BLES. (Geoffrey Bles. 6s. net).

This book is based on extracts from the diary of Dr. C. B. Tilanus, as edited by Professor H. T. Deelman of the University of Groningen. It is the record of the tour of three young Dutch doctors round the hospitals of Europe at the beginning of the

last century. It is not too easy for the scientist of to-day to envision the fantastic conditions of sepsis that prevailed in those not too distant times. The interest of the book centres perhaps more in the attitude of mind of the practitioners than in the detail of their work. We find these young and phlegmatic Dutch students attending a course of post-graduate work at the Paris hospitals, where they sit at the feet of the great men of the day—Larrey and Dupuytren. Operations are performed with great forethought, care and technical dexterity. The students are lost in admiration, but in nearly every case the patient dies, not of the operation—which was a success, but of something like a fever afterwards. It is regrettable, but apparently it was generally understood that the skill of the practitioner was not determined by his mortality list, but by his skill in diagnosis and operation. There are many interesting sidelights on the state of scientific knowledge at the time, and it is entertaining to read of the German museum where visitors had to tip the professor a shilling or so for showing them round. The book is a valuable contribution to a period recent enough for us to know little about, and one can only conclude that this generation had healthy ancestors. Invalid ancestors never survived their treatment.

Life, an Introduction to the Study of Biology. By SIR ARTHUR E. SHIPLEY. (Cambridge University Press. 6s. net).

The second edition of "Life" by Sir Arthur Shipley appears so soon after the first that the author may be justly accused of having written a scientific best-seller. The fact is unshakable, for the author gives us not only the true and accurate presentation of the story of biology as it is understood by scientists, but he writes it with a perfect literary style and a charm of expression which are all too rare. It is almost necessary to turn back to the great Victorians to find a writer who expresses himself so well and so clearly on his great subject. It is one of those rare books which illuminate a whole subject, and redeem and make comprehensible to the student the dry or less inspiring textbooks. The general reader, even if uninterested in science as such, will find that it opens to him magic gateways of new vision. It is suitable for any age, and there can be few books which could better grip the imagination of youth or exert a more inspiring influence. Readable as a novel is perhaps a hackneyed phrase, but there are few readers which this book would not interest. It cannot be too widely known or adequately enough recommended.

Musical Taste, and how to form it. By M. D. CALVOCOVINI. (Oxford University Press. 2s. 6d.).

The Appreciation of Music by means of the Pianola and Duo-Art. By PERCY A. SCHOLES. (Oxford University Press. 5s.).

Mr. Calvocovini, having examined modern methods of educating the musical taste and found them bad or, at any rate, misapplied in practice, comes forward with warnings and alternative suggestions. His book, which is addressed not to the teachers, but to amateurs eager for experienced guidance, is marred by a didactic style that is likely to antagonize many readers, but contains notwithstanding much that is of value. Especially useful is his criticism of those teachers whose misguided enthusiasm for "musical appreciation" has led them to unwise dogmatism and pedantic folly; these people are numerous, and their activities constitute a serious menace to the success of a system which, properly applied, seems capable of much good. Let them read Mr. Calvocovini and mend their ways!

Whether the amateurs for whom the book is intended will

gain much profit from it is more doubtful. So obsessed is the author by the fear of expressing just such dogmatic opinions as he deprecates in others, that he is forced back on a series of vague generalities that are too broad to be of much practical good. The art of music is itself so impalpable that what the beginner most requires is definite and precise statements that will give him a starting-off point from which to pursue his further investigations; he can safely be trusted to discard, as his experience grows, that which is disagreeable to his own temperament and to develop his taste in the direction of his natural bent. At the end of the book there is a list of music recommended for study; this, including as a single item, the whole of the compositions of Beethoven, Schubert, Schumann and Chopin, is too long to be of much use to the average amateur.

When we come to Mr. Scholes' book we have firm ground under our feet once more. Mr. Scholes is a well-known authority on "musical appreciation," and can be trusted to avoid the pitfalls against which Mr. Calvocovini warns us. His book covers familiar ground, containing as it does lectures on Bach, Handel, Haydn, Mozart, Beethoven, and "some of the composers since Beethoven," but its originality and usefulness consist in the manner in which the lecturer has selected his musical illustrations from works that can be performed on the piano, the pianola, or the "Duo-Art," this last an instrument that reproduces not only the music but its rendering by a particular player. The work may therefore be considered as a companion volume to Mr. Scholes' two "Books of the Gramophone Record." The possibilities of the pianola from an educative point of view are well worth emphasizing, and players of this instrument who desire to increase their knowledge and love of good music can safely be recommended to take Mr. Scholes as their guide. There is, happily, a plentiful supply of good pianola rolls, though these need careful management if the best results are to be obtained. The book includes an appendix, "On playing the Pianola," contributed by an expert, and the advice here given should be carefully followed by all who wish to make the most of this complicated and by no means soulless piece of mechanism.

PETER LATHAM.

Roving through Southern China. By HARRY A. FRANCK. (Fisher Unwin. 21s. net).

A photograph of the white author of this book pushing his embarrassed coolie in a wheelbarrow faces page 560 of this volume. Anything that the author has to say about Europeans in the East can be read in the light of this. He has written about China before if the wrapper of the book is to be believed. This seems to rule out ignorance as an excuse, and we can only attribute the present volume to lack of taste and faulty education. The book is a painful record of the writer's voyaging in China. His passing must have been an embarrassment to the white community, and a source of mirth to the Chinese. The reviewer has not read his previous publications but if they were like this book it is easily understood that the author was unwelcome everywhere. The book appears to be written for an uncritical American public.

Electricity and the Structure of Matter. L. SOUTHERNS, M.A., B.Sc. (Humphrey Milford: Oxford University Press. 2s. 6d. net).

For its price this book gives the reader astonishing value. There have been many books, some of them massive and expensive, which have attempted to give the general reader some coherent idea of the modern physical theory of the atom.

There have been pamphlets by authorities and pamphlets by hacks, but all fall short in some particular; either difficulties are glossed or undue stress is applied to the facile but dangerous analogies that are of necessity introduced in a "popular" book. The author is to be complimented on having treated electricity as it was understood to the end of the nineteenth century on historical lines. The twentieth-century developments of radio-activity, X-rays, and wireless, are treated more fully and furnish the reader with a line of approach to the problems of to-day which is largely freed from the shackles of dead theories. A full glossary and a short bibliography, the latter an extremely well-chosen one, add to the utility of a book whose form may well serve as a model for others.

Tales of the Eskimo. By CAPTAIN HENRY TOKE MUNN. (Chambers. 3s. 6d. net).

These short stories of the Eskimo folk are fiction, but founded on fact and even better founded on personal acquaintance with the people. They are extraordinarily good and interesting not only to children but also to grown ups. The author starts with a hair-raising yarn of being pursued by a band of neolithic sea-men who live in the sea and are covered with blubber like a seal. Anthropologists will wish the tale were true, but anyway it is satisfactorily curdling. The best part of the book is the stories which portray the life conditions under which the Eskimo manage to exist as a race of hunters seldom far beyond the shadow of starvation during the Polar winter.

Educational Psychology. By CHARLES FOX. (Kegan Paul 10s. 6d. net).

This book is important to the business man. There is something of a reaction against the old ideas that at a good school one absorbed a code or rule of life, and the author quotes at some length and apparently sympathizes with the doctrine expressed in print by some teacher that boys should be encouraged to "tell the head master" if he heard another boy "speaking in a low or vulgar way." We doubt that any healthy layman will find anything in the squalid chatter of complex sleuths which will seem to him much of an improvement for the old traditions. Yet the author quotes the desire of some teacher "to root out the bad old conception of schoolboy honour and to substitute something higher, nobler, more inspiring." This seems rather like the old-fashioned Jesuit system now abandoned except in very backward countries where any kind of sense of honour is necessarily an acquisition, and a rule of this kind is accepted as essential. Nevertheless, in this country the best Roman Catholic boys' schools are those of the Benedictines, and they are modelled on the ordinary English public school system and have entirely abandoned the old ideas so alluringly rediscovered by these would-be innovating psychologists. There is a great deal of matter in this book, but when all is said and done mighty little news and not much that will be useful to the reader.

Prehistoric and Roman Wales. By R. E. M. WHEELER, D.Litt., F.S.A., Director of the National Museum of Wales. (Clarendon Press. 18s. net).

Archaeology may be treated in two ways. It can be dreary or it can be readable. In the past leading authorities thought that they must be dull in order to be respectable, and that any show of enthusiasm or intelligibility would be thought by their colleagues to be playing to the gallery. To-day it is recognized in all progressive branches of science that it is wise to write books which can be read by the ordinary man as well as the critical expert. Doctor Wheeler's book is excellent.

It is far too good to be reviewed by some expert who would point out that he had omitted to mention an article of unknown use found at a place with a native name. It is a good book for the general reader, for it gives a thorough review of all that is known about prehistoric Wales. The volume is also magnificently illustrated, and the lay reader is not puzzled with references to objects he does not clearly understand. Layer by layer the early story of man in Wales is uncovered, and parallels are drawn between these and contemporary European cultures. The result is that in one volume the reader has a full and valuable record. There is only one point in which future editions might be improved: a short bibliography or guide to further reading on some of the subjects might appeal to those interested enough to seek further knowledge.

The Respiratory Function of the Blood. Part I: "Lessons from High Altitudes." By J. BARCROFT. (Cambridge University Press. 12s. 6d. net).

One does not look for a fascinating tale of mountain travel and experiment in a book with a title like this. Nevertheless, quite apart from its very great importance as a contribution to our physiological knowledge, the book is very readable. One may take it that the specialist in this branch of work will read the book in any case, but it will also interest Alpinists and airmen. The work done has proved to be enormously valuable, and the conquest of Mount Everest which is still deferred may yet be made possible as a result of greater knowledge of the function of our blood stream under conditions of reduced pressure and oxygen starvation.

Animal Life in the Sea. By R. J. DANIEL, M.Sc. (University Press of Liverpool. 5s. 6d. net).

Marine life is gradually attracting more attention, and little by little the public are becoming familiarized with its importance. The best way to educate the public is to educate the rising generation, and this little book, though suitable for adults, has just the required directness and interest which appeals to younger students. It covers a wide field from Plankton to the Sea Serpent, is well illustrated, and admirably sound.

Everyday Physics. By H. E. HADLEY, B.Sc. (Macmillan. 6s. 6d. net).

The inflexibilities of the examination system have led teachers to the small specialized textbook dealing with one branch of physics as a "subject." There is to-day a decided reaction against this type of pemmicanized knowledge and a recognition of the value of wider scope which a general knowledge of elementary physics involves. The elementary student is most easily led to an appreciation of the function of physics by the applications of physics in ordinary life.

For such an early course Mr. Hadley's book is eminently suitable. The author's name is a sufficient guarantee of its soundness to those who know his other books. The illustrations are good and for the most part new, and the number of modern appliances described and explained is remarkable.

The Families of Flowering Plants. Vol. I: "Dicotyledons." By J. HUTCHINSON, F.L.S. (Macmillan. 20s. net).

There has been a long-sustained attack on Bentham and Hooker, and this book is ambitiously designed to replace it. There are doubtless sound scientific reasons why Bentham and Hooker are a bit out-of-date here and there, but when all is said and done you can find Bentham and Hooker's *British Flora* in any decent country-house library, and it is a perfectly good

standby for the ordinary man and one has got used to working with it. The expert botanist may find Mr Hutchinson's book better and his key easier, but the student working in this country will not find a change warranted. The real utility of the book is for the traveller and the overseas man. How often has the traveller who is observant but not a botanist found a predominating feature of some scene to be a new and unfamiliar flower. I have eaten hundreds of Avocado pears, but never knew that they were related to my greenheart fishing rods. It will be a useful handbook in the tropics, and caters for the ordinary man by providing a glossary to explain words like "diadelphous," "gamosepalous," etc. These may be the small talk of the Linnean Society, but are not always easily translatable at settlements in the backwoods. In a future edition the author might consider the insertion of a purely elementary chapter for the guidance of the foreign-living non-botanist. It would be extremely popular and useful.

Practical Hints to Scientific Travellers. Edited by H. A. BRONWER, Professor of Geology, Delft. Four volumes. (Martinus Nijhoff. 8s. 6d. per volume).

These little books are useful, for each volume contains a series of papers by responsible field geologists on what clothes are best to wear and what kit is best for a given territory. New Guinea, the Arctic, India, Turkestan, British East Africa, and other parts of the world are treated separately. With the matter we have no quarrel. It is authoritative, if commonplace. The Anglo-Saxon is so well served by his societies and so instinct a wanderer that he seldom blunders over such questions of dress, equipment or gear. The books will, however, doubtless find a welcome on the Continent, where travel afield is more of an adventure than it is to us restless English. A few photographs, not exceptionally illuminating, are embodied in the books, but it cannot be said that the series represents value for money, and it would have been better to have incorporated the three volumes in one and at the price of one. The articles are mainly in English, with occasional communications in French. The article by Professor Bronwer is in English, but poorly translated. The books should not be confused with the standard work "Hints to Travellers" issued by the Royal Geographical Society.

A. H.

Three Men Discuss Relativity. By J. W. N. SULLIVAN. (Collins. 7s. 6d. net).

The "popular" expositions of relativity are said to make up more than fifty per cent of the bibliography of the subject. The dialogue in this volume takes place between a mathematical physicist, a philosopher, and an ordinary intelligent person. There is nothing wrong with the book except that the author is under the illusion that the layman remembers elementary algebra after he is of age. If you have a taste for mathematics the book may be comprehensible, but the author's conception of an ordinary intelligent person is—relative.

Evolution. By GRAHAM KERR, F.R.S. (Macmillan. 12s. net).

To Tennessee, to dear old Dixie, to Main Street and the Lutheran communities in general I commend the picture on page 57. "Figure 17, Abnormal ten-year-old boy with a visible tail." The recent breakdown of the American educational system manifested in the revolt of the Fundamentalists has brought forth a number of books on evolution. Most of the American ones are pretty poor stuff, though none is so utterly contemptible as the works of American teachers of science in which the whole question is avoided or emasculated into a hypocritical page of type. The good books have been at best mediocre; one sensed the playing down to the culture-snippetting

American reader, and one found no trumpet note of understanding and interpretation of evolution as a natural law and a perfectly ordinary wholesome thing. They made of it a dry thing dug out of geology, illustrated by plaster casts and quite, quite dead.

Professor Kerr's book has got a perfectly wonderful quality. He actually talks about evolution as if it were going on to-day. He sees it as a living thing. He illustrates its effect in butterflies, and drags in perfectly relevant parallels from savage tribes he has lived with. His story is drawn from the animal kingdom, his theme is life, and he has mercifully omitted that dreary diagram of *Drosophila* flies which has bored more students than any illustration of modern times. It is altogether a good book far and above the average, and besides its theme of evolution it has a valuable secondary characteristic. It is a sound guide to really scientific thinking and a valuable corrective to some of the cheap "scientific" posing of to-day. Heartily commended for general reading as well as to those interested.

Personality. By R. G. GORDON, M.D., M.R.C.P. (Kegan Paul. 10s. 6d. net).

A book on psychology from the standpoint of a practising physician is rather a relief after the voluminous if futile output of dons. Dr. Gordon's book shows some of the appreciation of the human element that is almost inevitably learnt in his profession, but although he writes an excellent précis of the influence and line of thought of Freud, Zung, Adler, and even Kempf, the book is essentially a thesis on psychology rather than a work for the medical practitioner. This is to be regretted, for psychology is sunk in a trough of disrepute and its salvation lies rather in the hands of sound medical practice than in its pseudo-industrial application. The latter has been defined as another thong for the slave-driver's lash, and it will require desperate efforts to save psychology from the fate of phrenology unless its application in the hands of qualified medical practitioners is more adequately stressed. The sole virtue in this half-science is its potential remedial value. This, loudly acclaimed in the past, is no longer stressed, and the growing doubt as to the value of this new fad to anybody but the job holder or the aspirant for a job finds echo in the public jeer.

Pegasus. By COLONEL J. F. C. FULLER. (Kegan Paul. 2s. 6d. net).

Colonel Fuller was one of the keenest supporters of the tank during the war. He sees the future economic development of the wilder roadless parts of the Empire as a problem to be met by the roadless or tractor vehicle. If one can neglect Woodruffe's theory of the effect of tropical light on white races, we may yet people Africa with British stock, but there are problems other than those of mechanical engineering which would have to be met before Colonel Fuller's optimism could be justified.

Modern Magnetism. By PROFESSOR FELIX ANERBACH. Translated by H. C. BOOTH, A.R.C.Sc. (Methuen. 15s. net).

Presents a sound survey of the theory of magnetism as understood to-day. The book is intended for teachers and advanced students, is well illustrated, and has an excellent bibliography of the subject. The treatment is simple within the limits of the subject, and mathematics is reduced to the minimum.

The Mathematical Theory of Electricity and Magnetism. By J. H. JEANS. (Cambridge University Press. 21s. net).

The mathematical mind will welcome the fifth edition of this textbook which now becomes an accepted standard work. Chapter twenty embodies a concise mathematical view of the relativity condition, and gives a conservative benediction to Weyl's electro-magnetic theory.

er-
l a
ry
te,

ty.
ay.
es,
oes
m.
ry
nts
od
of
a
ve
ily
an

ng
out
on
his
he
ren
er
ed,
on
its
as
ire
gy
cti-
his
lly
ng
ob

6d.

nk
of
aet
e's
yet
ner
be

ms-

er-
ced
hy
of

By

his
rk
the
to